JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES
VOL. 30 JUNE 15, 1940 No. 6

CHEMISTRY.—*A study of the association of magnesia with silica in a pure magnesium clay.*[1] P. G. NUTTING, U. S. Geological Survey.

A white clay occurring near Hector, Calif., described by Foshag and Woodford (1) was shown to be a nearly pure magnesium silicate of the montmorillonite type. It swells largely and disperses readily in water like the familiar Wyoming bentonites. Although composed almost entirely of a crystalline mineral, it is remarkable in that its magnesium may be completely removed (leaving pure silica) by electrodialysis. In view of this ready separation by electrical means, it seemed desirable to make solution analyses of this clay by the method previously described by the author. This method consists essentially of bringing the clay to equilibrium with various hot dilute solutions of acid or alkali and analyzing the resulting solution (2, 3). To clarify the interpretation of these analyses, pH determinations were made on each solution. Some rather remarkable results appear worth putting on record.

The magnesium is not removable by electrodialysis from a pure montmorillonite to any observable extent. From the Wyoming bentonites only the alkalies are thus removable. The swelling property of the Hector clay is doubtless due to its being saturated with alkali to base-exchange capacity, a property that, as shown by Mattson (4), is true for clays and soils in general. Alkali in the Hector clay amounts to 4.19 percent, of which 3.00 percent is Na_2O and 1.12 percent is Li_2O (1). Magnesium can not be exchanged for lithium or the lithium for magnesium, so that the exchangeable base is the 3.00 percent of Na_2O. The $1H_2O$ of water of crystallization is very firmly held, being released only above 650° C. (nearly 100° higher than in pure montmorillonite) and is completely removed only by heating to 1,000° C. Boiling with ammonium oxalate separates magnesium from silica as do of course the mineral acids. Sodium carbonate solutions remove the silica from the magnesium.

[1] Published by permission of the Director of the U. S. Geological Survey. Received January 14, 1940.

The white Hector clay forms a permanent hydrogel in water, but the light-brown clay associated with it does not and may be readily separated by settling and decantation. The stock suspension used contained 8 grams per liter. To 100-cc portions of this stock in pyrex flasks was added hydrochloric acid to make concentrations ranging from 0.01 to 4.00 percent, as shown in Table 1. The flasks were kept at 90°–92° C. for 24 hours, the clay filtered out with Whatman 42 filter paper, the filtrate evaporated, dried at 160° C., and weighed in pyrex beakers. The residue consisted partly of water-soluble chlorides. These were removed by boiling in water. The water-insoluble residue, after drying and weighing, was treated for 20 minutes with concentrated hydrochloric acid to separate bases and silica, and these were determined. Calcium, iron, and aluminum were negligibly small. Magnesium was determined as pyrophosphate. The pH determinations were made with a glass electrode apparatus on portions of the filtrate carefully brought to room temperature (29°±1°). The intermediate range of concentrations (0.063 to 0.63 percent) were repeated six times since in this range equilibrium is extremely sensitive to operating conditions.

The more significant results are given in the following table and are graphed in the figure.

TABLE 1.—SOLUBILITY OF HECTOR CLAY IN HCl SOLUTIONS AND pH OF VARIOUS CLAY SOLUTIONS

Initial HCl: Percent	In solution: Grams per liter			Initial acid: pH	Filtrate: pH			m.e.q. HCl per gm clay
	SiO_2	MgO Insoluble[1]	MgO Soluble[1]		Hector	Paria	Wyoming	
0.0	0.082	0.00	0.00	(0.01) 2.70	8.65	5.67	4.10	0.274
0.016	0.010	0.00	0.00	2.49	7.83	4.52	3.39	0.436
0.025	0.048	0.032	0.00	2.28	7.00	3.40	2.75	0.690
0.040	0.121	0.099	0.00	2.09	6.20	2.51	2.27	1.10
0.063	0.225	0.162	0.12	1.88	5.40	2.08	1.90	1.73
0.100	0.276	0.190	0.32	1.70	5.60	1.80	1.63	2.74
0.159	0.246	0.168	0.62	1.49	4.48	1.39	1.40	4.36
0.252	0.182	0.140	0.98	1.30	4.38	1.10	1.21	6.90
0.40	0.431	0.295	1.39	1.12	3.22	0.97	1.04	10.96
0.63	0.495	0.302	1.78	0.95	1.39	0.88	0.92	17.3
1.00	0.508	0.282	1.93	0.78	1.01	0.80	0.81	27.4
1.59	0.496	0.252	1.98	Fresh	9.90	9.52	9.55	(In H_2O
2.52	0.473	0.216	2.00	Cooked	—	9.10	—	only)
4.00	0.439	0.175	2.00	—	—	—	—	—

[1] After heating at 160° C.

The solubility of the Hector clay is of the same general character as that previously found (3) for the familiar Wyoming swelling bentonite. The reversal in slope in the concentration range of 0.1 to 0.25

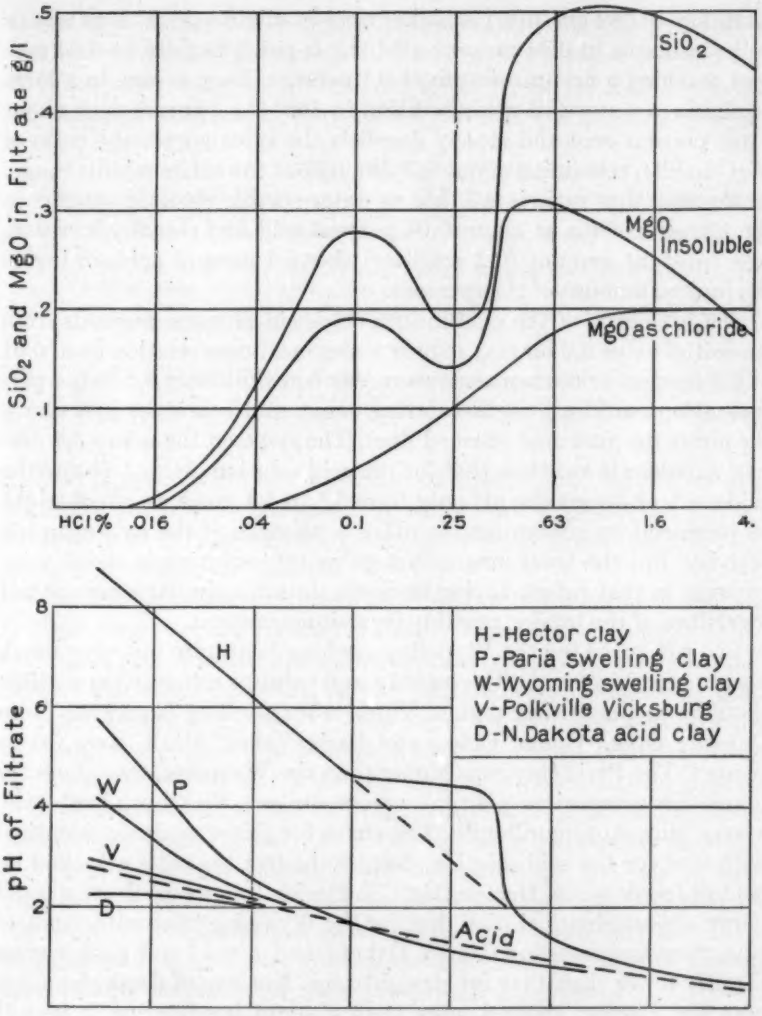


Fig. 1.—Solubilities and pH values for Hector clay.

percent acid occurs also in the curves for Wyoming bentonite in the range of 0.4 to 1.0 percent—four times the concentration. This reversal has been found in the nonswelling adsorbent clays low in sodium (2), but it can not be fully explained.

In pure water silica appears to dissolve as sodium silicate and the

solubility (0.082 gm/liter) is higher than in dilute acid. It is nearly or quite insoluble in 0.01 percent acid but is rising rapidly at 0.04 percent reaching a first maximum at 0.1 percent. Magnesium, in a form insoluble in water (after evaporation to 160° C.), appears with about 0.016 percent acid and closely parallels the silica curve, the ratio of MgO to SiO_2 remaining about 0.7 throughout the entire middle range. In the clay that ratio is 0.5. Mg as water-soluble chloride appears in the filtrate residue at about 0.04 percent acid and steadily increases to a constant amount (0.2 gm/liter) above 1 percent acid, owing to the limited amount of clay present.

The pH curve of the equilibrium clay-acid filtrates descends from the initial value 9.9 for clay in pure water in a linear relation from 0.01 to 0.1 percent acid, then remains nearly constant from 0.1 to 0.4 percent, drops suddenly to the normal value, and continues just above the curve for pure acid (dashed line). The slope on the 0.1 to 0.4 percent shoulder is *less* than that for the acid solution alone; trebling the acid content lowers the pH only from 4.6 to 4.4. Such an effect might be produced by adsorption, as pH is a measure of the hydrogen ion activity, but the total magnesium going into solution is steadily increasing in that range. Living bodies maintain a similar constant pH regardless of the intake, possibly for a similar reason.

The pH curve for the Wyoming swelling bentonite lies very much lower than that for the Hector clay and exhibits a barely perceptible shoulder in the critical region. Three other swelling bentonites from Ontario, Oreg., Como, Colo., and Paria Valley, Utah, were investigated. The Paria clay runs higher than the Wyoming, the others are lower. For comparison pH runs were made on a Vicksburg bentonite, a very pure montmorillonite. The curve for this was almost identical with that for the acid solution, despite the fact that it is attacked by acid as freely as the Hector clay (2). Florida fuller's earth gave a pH curve almost identical with that for the Wyoming bentonite. An acid clay from northeastern North Dakota and a field soil gave curves slightly lower than that for straight acid. Not one of these clays, except the Hector, showed more than a slight irregularity in its pH curve where the Hector clay has a pronounced shoulder. At higher acid concentrations, the Paria clay curve dips well under the curve for pure acid as though an excess of silicic acid were released.

Summary.—The white swelling Hector clay breaks down in hot acid solutions like the swelling Wyoming bentonite but at markedly lower acid concentrations. The pH curve of the filtrates from these suspensions not only runs much higher than that of any of the seven

other clays tested but exhibits a pronounced shoulder in an intermediate acid range not shown by the others. This shoulder indicates that hydrogen ions are inactivated either by physical adsoprtion or by chemical reaction, or that hydroxyl ions are released largely over a particular range.

LITERATURE CITED

1. FOSHAG, W. F., and WOODFORD, A. O. *Bentonitic magnesian clay mineral from California.* Amer. Min. **21**: 238–244. 1930.
2. NUTTING, P. G. *A study of clay solubility.* Franklin Inst. Journ. **224**: 339–362. 1937.
3. ———*The action of some aqueous solutions on clays of the montmorillonite group.* U. S. Geol. Surv. Prof. Paper. (Not yet published.)
4. MATTSON, SANTE. *The law of soil colloidal behavior: XIII. Forms and functions of water.* Soil Science **33**: 301–322. 1932.

PHYTOCHEMISTRY.—*Some new cyanogenetic plants.*[1] E. A. MORAN, R. R. BRIESE, and J. F. COUCH, U. S. Bureau of Animal Industry.

This paper reports the detection of hydrocyanic acid or of compounds capable of developing it in six species of plants not hitherto known to be cyanogenetic together with some figures for the HCN content of *Triglochin palustris.*

Emplectocladus fasciculatus Torr.—California desert almond, one of the Amygdalaceae, is found in California, southern Nevada, southern Utah, and Arizona, according to Tidestrom.[2] It is a small spinescent shrub closely related to the well-known cyanogenetic genus *Prunus.* It has not hitherto been reported as being cyanogenetic. Material was collected in 1936 in Wah Wah Valley, 30 miles west of Milford, Utah. This was dried and shipped to Washington. Analysis of the leaves showed a high HCN content of 172 mg per 100 g. Leaves collected on June 19, 1937, at 2 P.M. in the same locality were preserved in 1 percent mercuric chloride solution. Analysis of these samples at 4, 8, and 12 weeks after collection gave 132, 135, and 134 mg HCN per 100 g green. Neither acetone nor benzaldehyde could be detected in the distillates from these samples, and no clue was obtained as to the nature of the cyanogenetic glucoside.

Linum kingii S. Wats.—A perennial yellow-flowered flax found in Wyoming and Utah, according to Tidestrom, belongs to a recognized cyanogenetic genus. The common flax, *Linum usitatissimum,* is a well-known cyanogenetic species,[3] and several cases of poisoning of livestock have been traced to it. Fresh material was collected on

[1] Received January 3, 1940.
[2] TIDESTROM, IVAR. *Flora of Utah and Nevada.* Contr. U. S. Nat. Herbarium **25**. 1925.
[3] JORISSEN and HAIRS. Bull. Acad. Roy. Belg. (3) **21**: 529–540. 1891.

July 13, 1938, from the mountain sides near the Salina (Utah) Experiment Station of the U. S. Bureau of Animal Industry and at an altitude of 7,800 feet. The plants were then beginning to blossom. The fresh material was preserved in 1 percent mercuric chloride solution and shipped to Washington. On analysis after one month the sample gave 0.98 mg HCN per 100 g of plant. A sample preserved in water alone gave 1.07 mg under the same circumstances. This species is, therefore, only slightly cyanogenetic in the flowering stage.

Linum lewisii Pursh.—Prairie flax. A perennial blue-flowered species found, according to Tidestrom, from Manitoba to Alaska, southward to Texas, California, and Mexico. Fresh material of this species was collected on June 24, 1938, from a locality 10 miles southeast of Salina, Utah, at about 6,000 feet altitude. The fresh plant preserved in 2 percent mercuric chloride was shipped to Washington. The plants were in late-blossom and immature fruit stage of growth. Analysis after 2 months showed 69 mg HCN per 100 g or considerably more than *L. kingii* contained. If grazed by cattle or sheep, *L. lewisii* is likely to produce fatal poisoning.

Glyceria septentrionalis Hitchc.—The cyanogenetic properties of eastern mannagrass were discovered by George B. Reynard, of the U. S. Bureau of Plant Industry, who collected samples at Oakland, Md., on September 4, 1937. Mr. Reynard stated that the fresh grass gave a strong Guignard test for HCN. A partly dried sample that he submitted to the authors was identified by Mrs. Agnes Chase. On analysis it gave 30.9 mg of HCN per 100 g. Several other species of *Glyceria* have previously been reported to be cyanogenetic.[4] At the level of HCN found in the specimen *G. septentrionalis* should be dangerous to ruminants if eaten in quantity.

Centaurea americana Nutt.—Basket flower, American star thistle. Seeds of this plant were submitted by Robert Merz, Jr., of College Station, Tex. Hydrocyanic acid has been reported from the following species: *C. montana* and *C. solstitialis* by Couperot[5] and from *C. crocodylium* by Mirande.[5] The seed of *C. americana* gave 5.8 mg. of HCN per 100 g.

Stillingia dentata (Torr.) Britton and Brown. Dried plants collected by O. G. Babcock in the vicinity of Garden City, Tex., were supplied by Dr. H. L. Haller, of the U. S. Bureau of Entomology and Plant Quarantine. Mr. Babcock stated that the plant was very poisonous to sheep and that the circumstances of the poisoning indicated

[4] Cf. WEHMER, C. *Die Pflanzenstoffe*, Jena, 1929, Ergänzungsband, 1935; and ALSBERG, C., and BLACK, O. F. Journ. Biol. Chem. **21**: 601–609. 1915.
[5] WEHMER, C. *Loc. cit.*

the possibility of cyanogenetic glucosides and alkaloid being present. Analysis of the dry leaves and stems showed that 77.7 mg. of HCN per 100 g could be obtained after 24 hours of maceration in water. This method is known to give somewhat low results, and it may be concluded that the actual quantity potential in the dried plant is 10 to 20 percent higher than the figure stated. The quantity of material at hand was insufficient to permit further investigation of this point. At this level of HCN it can be said that this plant is very dangerous to cattle and sheep.

Triglochin palustris L.—Arrowgrass has been reported cyanogenetic[6] but much less is known about this species than the more important *T. maritima*, and no figures for its HCN content have been published. Material of *T. palustris* collected by J. H. Ehlers at Cheboygan, Mich., in August 1938 and dried was analyzed September 20. It gave 13.5 mg HCN per 100 g. The plant had flowered but was not yet in seed. The quantity of HCN found is considerably smaller than is customarily given by *T. maritima* dried samples of which commonly yield more than 100 mg of HCN per 100 g, and specimens running from 200 to 300 mg are not uncommon. One specimen growing under water contained only 13.4 mg calculated on the basis of fresh plant.

GEOLOGY.—*New formation names to be used in the Kingston Range, Ivanpah quadrangle, California.*[1] D. F. HEWETT, U. S. Geological Survey.

A thick series of sedimentary rocks of late pre-Cambrian age that occur in the Kingston Range have not heretofore been divided into mappable units. They have been referred to in adjacent regions by previous writers[2] as Algonkian strata. The series comprises about 6,500 feet of sandstone, conglomerate, quartzite, shale, and dolomite that crop out on the north and east slopes of the Kingston Range. They are somewhat similar to a series of rocks that occur in the Grand Canyon region of Arizona. This assemblage of sedimentary rocks in the Kingston Range is named the Pahrump series, from a nearby valley lying north and northeast of the Kingston Range. It rests unconformably on pre-Cambrian granite gneiss and is overlain unconformably by sedimentary rocks that probably represent the basal formation of the

[6] GRESHOFF, M. Pharm. Weekbl. **45**: 1165–1169. 1908; BLANKSMA, *ibid.* **50**: 1295–1302. 1913.

[1] Published by permission of the Director, Geological Survey, U. S. Department of the Interior. Received March 23, 1940.

[2] NOBLE, LEVI F. *Rock formations of Death Valley, Calif.* Science, n.s., **80** (2069): 173–178. 1934. HAZZARD, JOHN C. *Paleozoic section, Nopah and Resting Springs Mountains, Inyo County, Calif.* Calif. Journ. Mines and Geology, State Mineralogist's Rept. **33**(4): 288–339. 1938.

Paleozoic rocks, Lower Cambrian in age. The formations to be described are as follows:

Pahrump series { Kingston Peak formation. / Beck Spring dolomite. / Crystal Spring formation.

Crystal Spring formation.—This formation crops out in a belt that extends for 5 miles around the north slope of the Kingston Range and in two areas on the eastern slope of the range. The formation comprises about 2,000 feet of quartzite, arkose, shale, and limestone, intruded by sills of diorite and syenite, with beds of dolomite and chert at the top and thick coarse conglomerate at the base. The base of the formation has been observed at only one locality, on the west end of a ridge 2 miles east of Horse Spring. Here conglomeratic quartzite rests on pre-Cambrian gneissic granite. No fossils were found in the formation. The name of the formation is derived from Crystal Spring on the north slope of Kingston Range.

Beck Spring dolomite.—The Beck Spring dolomite conformably overlies the Crystal Spring formation and crops out conspicuously in a belt 6 miles long on the north slope of Kingston Range. Two smaller blocks of the dolomite, each about 1 mile long, crop out in the hills northeast and east of the range. The formation is made up largely of beds of light bluish-gray dolomite, 2 to 4 feet thick, separated by layers of shaly material, and is about 1,000 feet thick. No clearly identifiable fossils have been found in it, but layers of roundish concretions about half an inch in diameter, found at one place, may be of algal origin. Beds of oolite several feet thick are also numerous. The name of the formation is derived from Beck Spring on the north slope of the range.

Kingston Peak formation.—The Kingston Peak formation is an unusual assemblage of sediments that conformably overlie the Beck Spring dolomite. It crops out in a belt 20 miles long around the north and east slopes of Kingston Range but is interrupted by several faults. The formation is about 1,900 feet thick, along the western part of the belt, but at the east end it appears to be much greater. The formation consists of sandstone and limestone with a thick coarse conglomerate in the middle. The conglomerate is made up largely of subangular cobbles of limestone up to 12 inches in diameter with quartzite and granite cobble predominating near the base. This uncommon assemblage of sediments resembles the debris that forms fans on the border of the present valleys, called fanglomerate. The name of the formation is derived from Kingston Peak, the highest point in the range.

BOTANY.—*Three fungi destructive to free-living terricolous nematodes.*[1]

CHARLES DRECHSLER, U. S. Bureau of Plant Industry.

In several earlier papers (5, 6, 8, 9, 10) comparative treatment was accorded to 24 fungi that had been observed to subsist on free-living nematodes infesting old agar cultures started from diseased rootlets or from other decaying vegetable materials. As the agar media employed were of a concentration sufficient to insure a rather firm consistency together with relative freedom from liquid water, the cul-

[1] Received December 6, 1939.

tures provided approximately terrestrial rather than aquatic conditions, and therefore not only encouraged the multiplication of eelworms mainly terrestrial with respect to source and adaptation, but also permitted development of the similarly terrestrial fungi habitually destructive to them under natural conditions. The 24 fungi hitherto treated include representatives of two distinct groups—21 species, mainly predaceous in mode of attack, being referable to an interrelated series of hyphomycetes wherein are embraced members of the genera *Arthrobotrys*, *Trichothecium*, *Dactylella*, *Dactylaria*, *Triposporina*, and *Tridentaria;* the remaining 3 species being referable to the Zoopagaceae, a distinctive family of conidial phycomycetes mostly destructive to terricolous rhizopods.

Apart from recognizable members of the predaceous mucedinaceous series and of the Zoopagaceae, about a score of additional fungi have been observed to destroy free-living nematodes in agar cultures. Nearly all these forms are parasitic in their mode of attack, infecting their hosts by germination of adhering conidia. Only one among them, the widely distributed and very destructive *Harposporium anguillulae* Lohde, can with any certainty be referred to a species previously reported as parasitic on nematodes. This meager agreement with earlier findings is not surprising when it is considered that in large part the literature on fungus parasites of nematodes records observations made on animals kept under conditions widely different from those obtaining in agar cultures. The relevant contributions by Braun (3), Sorokine (23), Sadebeck (19), Dangeard (4), Lindner (13), Maupas (16), Micoletzky (17), and Sparrow (24, 25) dealt presumably with infections of actively motile eelworms that came about under conditions apparently more nearly aquatic than terrestrial. Baunacke (1), Goffart (11), Korab (12), and Rozsypal (18), on the other hand, were concerned with parasites destructive to the eggs and the almost equally inert larvae in cysts of *Heterodera schachtii* Schmidt. Now, manifestly, infection of active eelworms by fungus spores under aquatic conditions, and infection of inert stages under terrestrial conditions, are not attended by the difficulties usual in infection of actively motile eelworms under terrestrial conditions. For in their brisk movement through soil or through decaying organic materials, terricolous nematodes constantly tend to scrape away the spores adhering to them externally, much as cattle rid themselves of the larger stinging flies in walking through dense shrubbery. Small size, slender or flattened shape, and strong adhesiveness are among the physical attributes whereby the spores of successful parasites are enabled to

withstand the adverse mechanical action to which they are exposed. In the two phycomycetous parasites herein described some of these attributes are derived from developmental modifications that appear to be of taxonomic significance.

HAPTOGLOSSA HETEROSPORA

A fungus evidently referable to one or another of the several zoospore-producing groups in the Phycomycetes has frequently been observed destroying enormous numbers of nematodes in agar cultures prepared from media of rather soft consistency and planted with decaying portions of roots or stems originating in greenhouse or field. It has also been found destroying nematodes in agar cultures that after being permeated with *Pythium* mycelium had been further planted with pinches of leaf mold collected in deciduous woods in Virginia, Maryland, or Wisconsin. Most of the species of eelworms commonly infesting soft agar cultures started from vegetable materials that have undergone partial decomposition in contact with moist ground, appear susceptible to attack by the fungus, though differences in the rapidity of their destruction are often noticeable. The appearance of the fungus in a petri-dish culture leads usually within a few days to the extermination of all active individuals of the susceptible species present. In its spectacular destructiveness and widespread distribution the fungus invites comparison with *Harposporium anguillulae* and with the larger of the retiary predaceous hyphomycetes, particularly *Arthrobotrys oligospora* Fres., *A. conoides* Drechsl., *A. musiformis* Drechsl., and *Dactylaria thaumasia* Drechsl.

During the earlier stages of its development within a nematode the fungus is relatively inconspicuous. At about the time the infected animal becomes incapable of further locomotion, the parasite may be discerned imbedded in the granular and globulose material resulting from degeneration of musculature and organs (Fig. 1, A). With further appropriation of the degenerating material it improves markedly in visibility and increases somewhat in volume (Fig. 1, B), so that when the last remnant of digestible substance has been absorbed, it is revealed with much distinctness inside the otherwise empty host integument (Fig. 1, C–G).

In an individual host animal the parasite may be represented by a single thallus (Fig. 1, F) or by many thalli (Fig. 1, A–E, G). Instances of infection by a single thallus or by two or three thalli are especially frequent early in the course of an epizootic. As the epizootic continues the number of thalli in the individual infected eelworm increases rapidly, with the result that in the end instances of infection by more than 50 (Fig. 1, C) or even more than 100 thalli are not infrequent. This increase in number, naturally, is accompanied by proportional decrease in size, and, somewhat secondarily, by some change in shape; the larger vegetative bodies being generally of cylindrical conformation, with bluntly rounded ends, whereas the smaller specimens are mostly of prolate ellipsoidal conformation. Irregular modifications of outward form, such as median constrictions and narrowed terminal prolongations, occur here and there. The larger vegetative bodies are frequently somewhat curved or crooked, either because of crowding by their fellows (Fig. 1, B, G), or because of constraint from the posture taken by the host animal in its death (Fig. 1, F).

Following exhaustion of their food supply the thalli of the fungus are transformed into sporangia. The smaller specimens (Fig. 1, I, J, K) each put

forth laterally a single broad protrusion that presses the animal's integument outward in a perceptible bulge. More or less simultaneously cleavage lines appear in the granular protoplasmic contents, dividing them into units of approximately equal volume. Suddenly the broadly rounded tip of the protrusion yields, and the delimited protoplasmic lumps are in large part forcibly expelled through the opening. Transformation of the larger thalli usually entails development of several protuberances at some distance from one another. In instances where five or six beaks are formed, two or three of them may participate in dehiscence. Regardless of the number of openings present, a considerable proportion of the protoplasmic lumps usually fail to be discharged (Fig. 1, H, *b*, *c;* L, O), and must await their liberation by the disintegration of host integument and sporangial membrane.

After being propelled some distance into the adjacent medium, the discharged protoplasts round up individually to form irregularly globose immotile spores (Fig. 1, H, *c;* L). Each of the encysted bodies soon gives rise to a bud, which then grows out (Fig. 1, Q) to form eventually a flattened structure with an elongated lateral lobe that is usually curled at its tip in a tonguelike manner (Fig. 1, M). Often the axial or proximal portion of the flattened structure, like the envelope of the immotile spore to which it remains attached, is found evacuated of contents, all of the protoplasmic material having been collected in the glossoid lobe. Before long, hundreds of the curiously constituted units thus resulting from asexual reproduction surround the integumentary remains of each host animal like a dense cloud.

When a healthy nematode passes through such a cloudlike array, some of the reproductive bodies become fixed to it; attachment being accomplished apparently through adhesion of the concave surface of the glossoid lobe to the animal's integument. Upon perforation of the integument by a minute opening the protoplasmic contents of the reproductive body migrate inward to form a small saclike structure. This structure then proceeds to develop autonomously, thereby again giving rise to a cylindrical or ellipsoidal thallus.

During the later and more readily discernible stages in their development some of the thalli can be seen attached to the animal's integument by a conical connection devoid of protoplasmic contents (Fig. 1, G). In this conical part is to be recognized unquestionably the saccate body by which invasion was initiated. The larger number of thalli, however, show no evident connection to the integument, a circumstance that might imply either that thalli often multiply by division, or that connections originally present often are destroyed as a result of movement by the animal. An approximate end-to-end arrangement of thalli (Fig. 1, A, B) occasionally to be observed argues somewhat in favor of the former alternative, while the latter is supported more especially by the frequent absence of any observable connection between integument and fungus in animals parasitized by only a single thallus (Fig. 1, F). Since such single thalli, when occurring in large animals, attain impressively large dimensions without dividing into units of smaller size, it may be presumed that vegetative division is at least not a constant feature in the development of the fungus. The presence of very numerous thalli in infected animals during the later stages of an epizootic in an agar culture is very obviously attributable to the enormous numbers of germinated spores then distributed through the medium. Often in such later stages the incipient infections from individual spores are so numerous and close together that the intruding protoplasts, operating virtually as a mass, will extensively separate integument from naked musculature. In the head region, especially, such wholly pathological separation—not to be confused with hastened

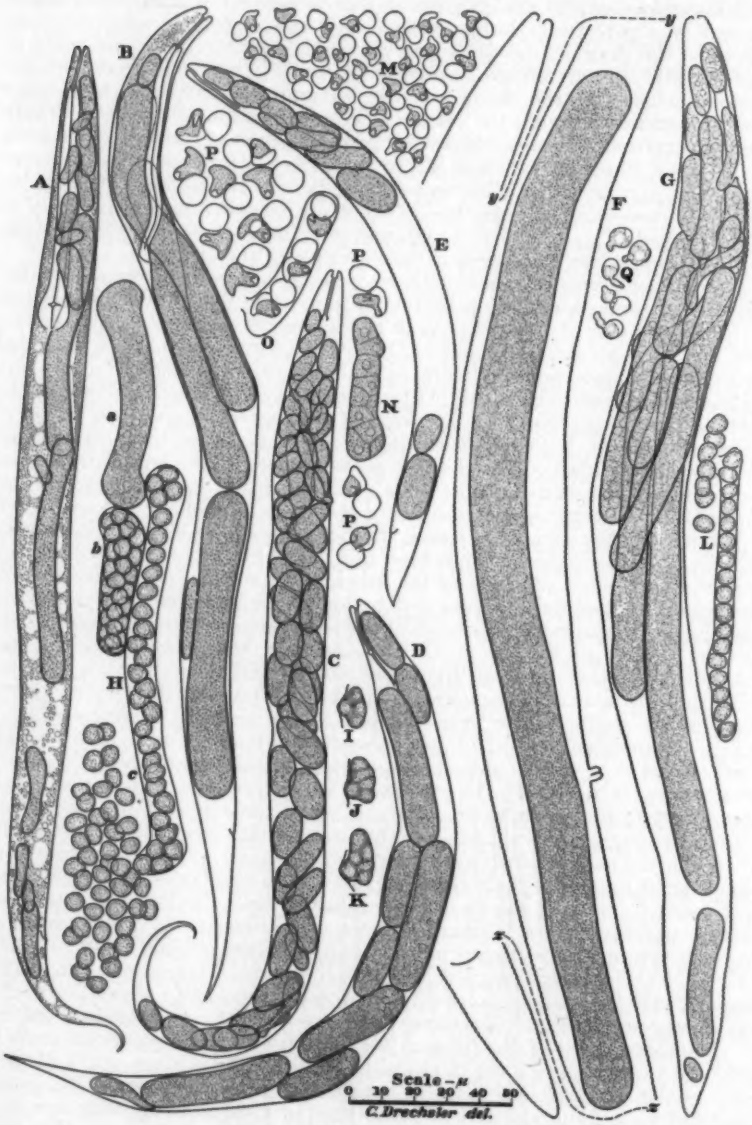


Fig. 1.—(See opposite page for explanation)

molting—is often associated with conspicuous deformation of fleshy structures.

With respect to size the immotile spores from each individual sporangium show only moderate variation. Most frequently, perhaps, they range in diameter between 4.5 and 6μ (Fig. 1, H, *b*, *c;* L; M). Many sporangia, however, give rise to spores ranging in diameter between 8 and 10μ (Fig. 1, N; O; P). It is not apparent that spores of intermediate dimensions are produced except as unusually oversized specimens in clusters referable to one category, or as undersized specimens in clusters referable to the other category. As sporangia producing the larger spores frequently occur in the same host animal with sporangia producing the smaller spores, the difference in dimensions can not readily be held traceable to differences in environmental conditions. Unstained living material reveals no divergence in manner of development or in mode of infection associated with the inequality of size.

Presumably the production of flattened lobate or glossoid infective structures by the discharged immotile sporangiospores represents a developmental process equivalent to the emission of motile zoospores from encysted sporangiospores familiar in the saprolegniaceous genera *Achlya* and *Aphanomyces*. Certainly, the type of asexual reproduction concerned here shows less similarity to the *Pythium*-like reproduction that is found associated with more or less swollen endoparasitic thalli in the genera *Lagena*, *Lagendidium*, and *Myzocytium*, than to the *Achlya*-like reproduction associated with swollen endoparasitic thalli in *Ectrogella* and *Aphanomycopsis*, as these genera were understood by Scherffel (21). With *Ectrogella* and *Aphanomycopsis*, moreover, the fungus under consideration offers further morphological parallelism in the pronouncedly grandular consistency of the protoplasm in its thalli—a consistency which Scherffel held with some justification to distinguish the Saprolegniaceae and Peronosporales from the Ancylistales and Chytridiales.

In its curious emission of immotile infective structures from immotile sporangiospores the fungus would seem to provide a plausible transition between the *Achlya*-like diplanetism of *Ectrogella* and *Aphanomycopsis*, on the one hand, and the direct discharge of immotile infective sporangiospores in *Protascus subiliformis* Dangeard (4), a parasite destructive to nematodes, on the other. The existence of such a transitional type of asexual reproduction lends support to Maupas (16) and Maire (14) in their interpretation of the conical sporangiospores of *P. subiliformis* as bodies homologous to motile

Fig. 1.—*Haptoglossa heterospora*, drawn to a uniform magnification with the aid of a camera lucida; × 500 throughout. A, B, C, D, Nematodes probably referable to *Rhabditis doiichura* Schneider, containing respectively 16, 5, 54, and 10 thalli of the fungus. E, Nematode, referable to *Cephalobus* sp., containing 10 thalli of the fungus. F, G, Specimens of *Acrobeloides bütschlii* (De Man) Thorne occupied respectively by 1 and 18 thalli of the fungus; owing to lack of space F is shown in three parts, which connect at the points *y* and *z*. H, Three neighboring thalli: *a*, in an early stage of transformation into a sporangium, showing two papillae of dehiscence; *b*, a sporangium, partly evacuated, within which the numerous retained spores have encysted; *c*, a sporangium showing in profile a papillar orifice through which many zoospores have been discharged, though a large number, too, have encysted within. I, J, K, Three small sporangia, each showing a papilla of dehiscence some little time previous to discharge of spores. L, Sporangium after partial emission of spores. M, Discharged spores of the usual smaller size, each of which has given rise to a lobate infective body. N, Sporangium with two papillae of dehiscence; its contents showing demarcation into spores of the larger size. O, Sporangium within which three spores of the larger size have germinated to form infective bodies. P, Spores of the larger size, each with an infective body attached to it. Q, Spores of the smaller size, showing different stages in the emission of infective bodies.

zoospores of the aquatic phycomycetes. Indeed, the transitional type of sporangiospore development herein set forth may have been known to these authors, as Maupas took occasion to allude to "les spores, également immobiles, de mon *Ectrogella?* sp." I have not found any published account of the form to which this allusion applied, yet as it is recorded by his obituarist (22) that Maupas worked rather extensively on fungi parasitic on nematodes, the doubtful *Ectrogella* species may have been encountered as a parasite on eelworms, and may therefore have been a fungus related to, or perhaps even identical with, the one under discussion.

Achlyogeton entophytum Schenk and *A. rostratum* Sor., both reported by Sorokine (23) as being parasitic on nematodes, differ from my fungus in that their thalli become partitioned into somewhat distended segments, which, though functioning individually as sporangia, remain connected with one another. In their development the zoospores of *A. entophytum* reveal an *Achlya*-like diplanetism, except for the difference, if Schenk's account (20) is to be trusted, that the motile stage is uniciliate rather than biciliate. While Schenk's representations relative to the number of cilia are so much at variance with expectations that their correctness has been questioned, the observations of Martin (15) and Tokunaga (26) have corroborated the existence of a secondary motile stage; and it seems certain, at least, that in *A. entophytum* the zoospore protoplast does not remain attached to the empty cyst envelope as an immotile infective body.

Erection of a new genus, under a name compounded of two words meaning "to fasten" and "tongue," is made necessary by the curious development of the sporangiospores in the present fungus.

Haptoglossa gen. nov.

Thalli singuli vel complures in viva animalia crescentes, elongato-cylindrati vel elliptici, maturitate protoplasmatis dense granulosi repleti, omnino sporangia evadentes; sporangio uno vel aliquot tubis papillisve mox instructo, sporas inertes expellente; sporis inertibus a vesicula non circumdatis, quisque corpus planum inertem inficiens proferente.

Vegetative thalli elongate-cylindrical or ellipsoid in shape, developing singly or in variable numbers within living animals, at maturity filled with densely granular protoplasm and in their entirety becoming converted into sporangia; the individual sporangium provided with one or several evacuation tubes or evacuation papillae, through which ready-fashioned spores are forcibly expelled without formation of any enveloping vesicle; spores immotile and without cilia, each putting forth an immotile infective body, often of flattened lobate shape.

Haptoglossa heterospora sp. nov.

Thalli hyalini, elliptici vel elongato-cylindrati, 7–350μ longi, 4–18μ crassi; sporangiis 1–6 humilibus papillis praeditis, per 1–4 ora 4–7μ lata dehiscentibus, aliis sporas 4.5–6μ crassas aliis sporas 8–10μ crassas eicientibus; sporis hyalinis, globosis vel rotundo-angulosis; corporibus inficientibus planis, 5–10μ longis, a latere lobo lingulato curvato 3–8μ longo apice attenuato instructis.

Vermiculos nematoideos multarum specierum enecans habitat in terra et humo silvestri et materiis plantarum putrescentibus in Maryland et Virginia et Wisconsin.

Vegetative thalli hyaline, ellipsoidal or elongate cylindrical, 7 to 350μ long, 4 to 18μ in transverse diameter; sporangia developing 1 to 6 short

broad papillae of which 1 to 4 may be functional in providing apertures of dehiscence mostly 4 to 7μ wide. Spores hyaline, globose or with rounded angles, those produced in some sporangia 4.5 to 6μ in diameter, those produced in other sporangia mostly 8 to 10μ in diameter. Infective bodies flattened, consisting individually of an axial portion 5 to 10μ long, together with a broad-based glossoid lobe mostly 3 to 8μ long, more or less upcurved at its tapering end.

Destroying nematodes of many species, it occurs in soil, leaf mold, and decaying vegetable materials in Maryland, Virginia, and Wisconsin.

MERISTACRUM ASTEROSPERMUM

A conidial phycomycete manifestly related to the entomogenous Entomophthoraceae was observed destroying nematodes in some agar plate cultures to which had been added pinches of leaf mold taken from deciduous woods near Butternut, Wis., in September, 1938. Among the eelworms subject to destruction several species belonging evidently to the genera *Rhabditis*, *Aphelenchoides*, and *Plectus* could be distinguished.

Infection is accomplished by the fungus in question through the germination of a conidium or of several conidia attached to the integument of a susceptible animal, most often toward its anterior end (Fig. 2, A, B, C). Usually the means of attachment is clearly visible in a sizable deposit of adhesive material between spore and integument. The proximal portion of the germ tube—the portion most directly concerned in penetration of the integument—is commonly set off from its distal continuation within the fleshy interior by yellow coloration and somewhat irregular thickening of its wall. When the invading element has attained a length of approximately 10μ, it widens abruptly to form a terminal swollen body, in which the protoplasmic contents of the conidium and infection tube then migrate. The swollen body thereupon continues its development by extending itself lengthwise through the animal as a stout assimilative hypha or thallus. Progressive destruction of musculature leads to increasingly pronounced disablement of the eelworm, and finally to its death. Vegetative growth of the assimilative hypha comes to an end only when the digestible contents of the host have been completely appropriated.

Early in the course of an epizootic within a petri-dish culture, infection of nematodes by single conidia is more frequent than infection by plural conidia. Later, as conidia of the fungus become more abundant, plural infection, with resultant development of two (Fig. 2, B, C, D), three, or four thalli, tends to predominate. On conclusion of their vegetative growth the assimilative hyphae, with the exception of occasional small specimens, undergo division into a number of segments, which appear rather obviously homologous to the "hyphal bodies" familiar in the entomogenous genera *Empusa* and *Entomophthora*. Division in each instance is accomplished by deposition of a cross wall (Fig. 2, D, *b*, *c*) and subsequent disarticulation of the delimited parts. The thallodic segments may be elongate-ellipsoidal (Fig. 2, D, *a*, *e*), or somewhat curved-cylindrical (Fig. 2, D, *b*, *c*, *g*); or, again, may have a more irregular shape with bulging expansions (Fig. 2, D, *f*) or short diverticulate lobes (Fig. 2, D, *d*).

Asexual reproduction may be considered to begin when the individual thallodic segment puts forth a hypha, about 3.5 to 5μ wide, that after emerging from the enveloping host integument grows through the overlying medium (Fig. 2, E, F) out into the air. If the host animal has succumbed deep in the medium, the outgrowing hypha often needs to make its way

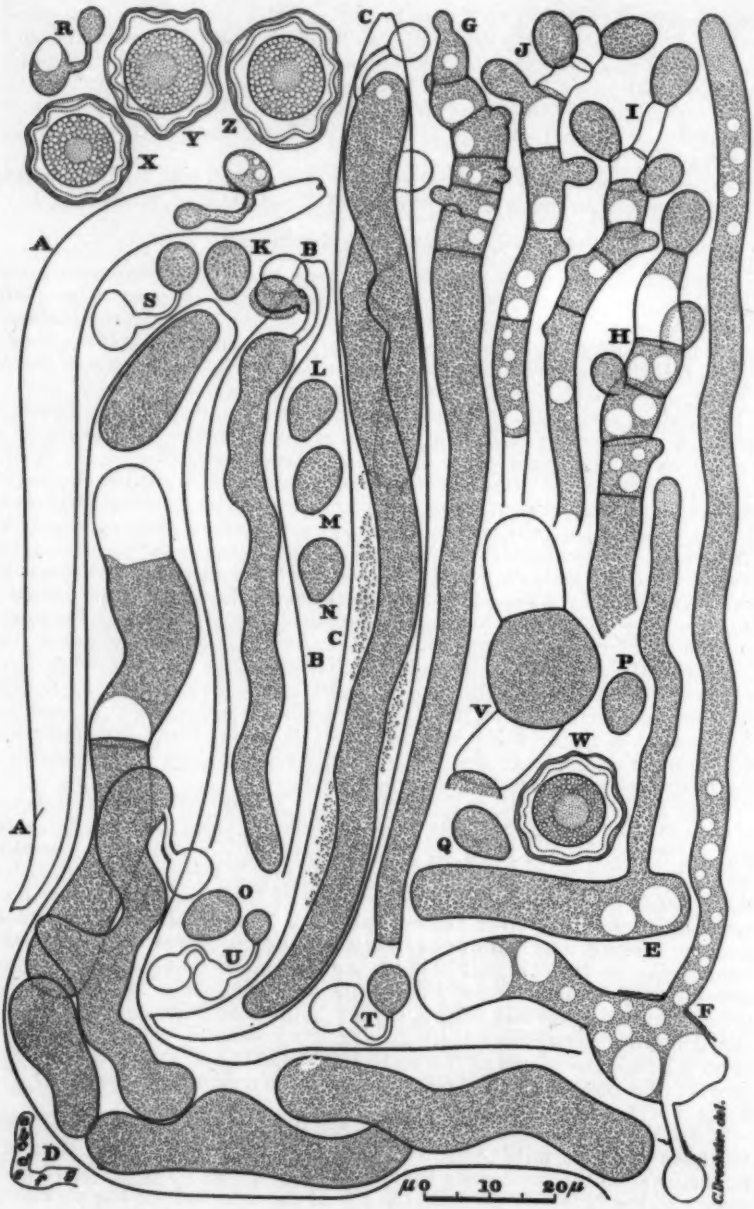


Fig. 2.—(See opposite page for explanation)

through solid material for a distance of 1 to 3 mm; whereas if the animal happened to die on the surface the hypha may extend itself into the air immediately. The aerial hypha or aerial prolongation, usually less than 0.5 mm in length, widens out perceptibly in its distal portion, and rather commonly is disposed here in a helicoid spiral of two, three, or four turns (Fig. 3, A). Into this somewhat modified terminal portion of hypha is soon transferred all the protoplasm from the entire thallodic or reproductive unit. Transverse septa are now laid down in basipetal succession, dividing the densely filled hyphal termination into cells of approximately equal protoplasmic content. After a bud has been put forth terminally from the apical cell, a similar bud is put forth laterally in basipetal succession from each of the lower cells (Fig. 2, G), each of the buds receiving the entire protoplasmic contents of the parent cell (Fig. 2, H, I, J), and then being delimited by a basal septum as an obovoid conidium (Fig. 2, K–Q). Detachment of the conidia appears to ensue spontaneously soon after they attain full development. Once they lie on the surface of the medium they are ready to adhere to any susceptible nematode that may come in contact with them; such adhesion then inaugurating another sequence of endoparasitic and reproductive development. However, when opportunity for infection is not presented within a certain period of time, the detached conidium gives rise to a secondary conidium closely resembling the primary one except for its somewhat smaller size (Fig. 2, R, S, T). The secondary spore is regularly borne aloft a few microns above the surface of the medium by means of a delicate filament often more or less prostrate in its proximal portion, but ascending or erect in its distal portion. Through development similar to that whereby it originated a secondary conidium may in turn give rise to a tertiary one (Fig. 2, U).

Frequently a thallodic segment, instead of putting forth a conidiophorous filament, forms a resting spore. By continued enlargement of a vacuole at each end of the segment (Fig. 2, D, *b*) the granular materials are brought together into a globose mass, which then lays down two somewhat convex end walls to form a subspherical cell (Fig. 2, V). The densely granular contents of this cell now are converted into an endogenous spore that is provided with a separate wall of its own. This wall appears prominently scalloped in profile, and only rather loosely surrounds the coarsely granular subspherical

---

Fig. 2.—*Meristacrum asterospermum*, drawn to a uniform magnification with the aid of a camera lucida; × 1000 throughout. A, Specimen of *Plectus communis* Bütschli showing early stage of infection by a germ-tube from an adhering conidium. B, Anterior portion of a specimen of *Rhabditis dolichura* with two adhering conidia, one of which has given rise to a growing vegetative thallus in the animal. C, Parasitized nematode, possibly referable to *Aphelenchoides* sp., the contents of which have been almost completely appropriated by two thallii. D, Portion of a specimen of *R. dolichura* containing seven thallodic segments of the fungus, *a–g;* one of these segments, *b*, which is not yet separated from its neighbor *c*, shows an early stage in the development of an azygospore; the other segments, *a*, *c–g*, subsequently put forth conidiophorous filaments. E, Thallodic segment from which a conidophorous filament is being put forth. F, Thallodic segment (with envelope of empty spore attached) likewise with an elongating conidiophorous filament. G, Sporiferous termination of conidiophorous filament, showing basipetal deposition of septa, and early stage in the budding forth of conidia from the delimited cells. H, I, J, Later stages in formation of conidia. K–Q, Disarticulated primary conidia. R, Primary conidium in process of producing a secondary conidium. U, Empty envelopes of a primary and a secondary conidium shown attached to a tertiary conidium. V, Same thallodic segment as D, *b*, but at a later stage, showing delimitation of the sporangial cell within which an azygospore is to be produced. W–Z, Mature azygospores, each within its sporangial wall.

protoplast, in which, on advancing maturity, a homogeneous central reserve globule may be distinguished (Fig. 2, W–Z).

With respect to the disposition of the membrane and contents of its resting spores the fungus shows striking similarity especially to the members of the genus *Endocochlus* (7), in the Zoopagaceae. Although in the few known species of *Endocochlus* the resting spores are always formed as a result of sexual union between portions of separate thalli, development of azygospores in a manner inviting comparison with the fungus under discussion is present in at least one member of the Zoopagaceae, namely in *Zoopage cladosperma* Drechsler (7). Resemblance to the genus *Endocochlus* is expressed also in the production of conidia by individual segments delimited through deposition of cross walls in aerial hyphae. This parallelism in asexual reproduction may well be of taxonomic significance despite some divergence in outward morphology apparent not only in the widening of the sporiferous termination, but also in its helicoid modification. The fungus under discussion shows further similarity to many endoparasitic Zoopagaceae in the frequently rather extended migration of its protoplasm from deeply immersed thallodic segments to the aerial terminations of its conidiiferous hyphae.

However, if the granular consistency and ready mobility of its protoplasm are considered together with the division and disarticulation of its vegetative hyphae into disconnected segments, the fungus appears more intimately akin to the Entomophthoraceae than to the Zoopagaceae. The indeterminate elongation of its conidiophorous filaments finds a close parallel in the indeterminate extension of external hyphae from the intramatrical mycelial segments in species of *Ancylistes*, a genus recently shown by Berdan (2) to be properly referable to the Entomophthoraceae. In their obovoid shape the conidia of the fungus reveal a very obvious similarity to those of many species of *Empusa* and *Entomophthora*. Often, besides, a fully developed conidium was seen to be attached to a dome-shaped protrusion of the parent cell; and the denuded empty conidiiferous cells were nearly always found badly collapsed, much like conidiophores of *Conidiobolus villosus* Martin some time after their energetic discharge. Although these details indicate a parallelism with the genera in the Entomophthoraceae known for their forcible projection of conidia, I did not succeed in demonstrating that the fungus under discussion likewise discharges its asexual spores forcibly. It seems probable, however, that the primary conidia are actively propelled, though with much less violence than in species of *Empusa*, *Entomophthora*, and *Conidiobolus*. The secondary and tertiary conidia are almost certainly never shot away, but are produced and held in slightly elevated positions, where opportunity for contact with nematodes given to surface locomotion appears especially favorable.

In the Entomophthoraceae the fungus is distinguished from those hitherto made known by its production of plural conidia, for the most part laterally, on a multiseptate conidiophore. It is accordingly described as the type of a new genus of that family. A term compounded of two words meaning "divided" and "tip" respectively, is deemed an appropriate name for the genus. The sculpturing of its azygospore wall suggests for the fungus a specific epithet made up from two words meaning "star" and "seed," respectively.

Meristacrum gen. nov.

Hyphae assumentes intra animalia viva crescentes, simplices vel nonnihil ramosae, primo continuae, postea—animali emortuo et carne ejus consumpto—in aliquot partes se diffindentes; his partibus disjunctis aut

hyphas fertiles emittentibus aut sporas perdurantes (zygosporas vel azygosporas) gignentibus; hyphis fertilibus in aere se porrigentibus, sursum protoplasmatis repletis, ibi primo continuis, deinde transverse multiseptatis, ex quaque cellula conidium proferentibus.

Vegetative hyphae developing within living animals, simple or somewhat branched, at first continuous, later (after death of the animal and exhaustion of its fleshy contents) often dividing into disjointed segments, which either put forth conidiophorous hyphae or give rise to resting spores (zygospores or azygospores); the individual conidiophorous hypha extending some distance into the air, in its densely filled terminal portion becoming divided by transverse septa into a number of cells, each of which then produces a single conidium.

Meristacrum asterospermum sp. nov.

Hyphae assumentes hyalinae, simplices vel parvulum ramosae, saepius 50–500μ longae, 5–12μ crassae, in articulos disjunctos plerumque 25–60μ longos se diffindentes; quoque articulo mox utrimque rotundato, aut unam hypham fertilem emittente aut unam azygosporam gignente; hyphis fertilibus saepe 0.5–3 mm longis, 200–500μ in aere se porrigentibus, parte propiore saepe immersa 3–5μ crassa mox vacua et sparsum septata, parte ulteriore aeria saepius in spiram levem contorta, 6–9μ crassa, primo protoplasmatis repleta, continua, deinde in 5–15 cellulas 4–20μ longas divisa quae singula conidia proferunt. Conidiis hyalinis, obovoideis, plerumque 8–11μ longis, 6–8μ crassis, modo singulas hyphas germinationis circa 10μ longas, 1.5μ crassas in vermiculum nematoideum intrudentibus, modo quoque unum conidium ordinis secundi ex hypha germinationis assurgente 5–10μ longa, basi circa 2μ et apice 0.8μ crassa ferente. Azygosporiis hyalinis vel flavidulis, globosis, circa 15–20 crassis, maturitate membrana late verrucosa vel undulata cellulam viventem sphaeroideam 11–14μ crassam laxe circumdante.

Vermiculos nematoideos enecans habitat in humo silvestri prope Butternut, Wisconsin.

Vegetative hyphae hyaline, simple or slightly branched, mostly 50 to 500μ long, 5 to 12μ wide, when well developed dividing into segments 25 to 60μ long; the thallodic segments becoming rounded at their ends, each putting forth a single conidiophorous filament or giving rise to a single azygospore. Conidiophorous filaments mostly 0.5 to 3 mm long, usually extending 200 to 500μ into the air; the proximal part usually 3 to 5μ wide, soon becoming empty and septate at long intervals; the distal prolongation, often 6 to 9μ wide and noticeably disposed in a helicoid spiral, becoming divided through basipetal deposition of transverse cross walls into 5 to 15 cells, mostly 4 to 20μ long, each of which by budding gives rise to a single sessile, hyaline, obovoid conidium, 8 to 11μ long and 6 to 8μ wide. Conidium after disarticulation often adhering to a nematode, then thrusting into it an infective germ tube, about 10μ long and 1.5μ wide, which develops into a vegetative hypha; or, failing to adhere to a nematode, giving rise on an ascending sporophore, 5 to 10μ long, 2μ wide at the base, and 0.8μ wide at the tip, to a somewhat smaller secondary conidium. Azygospore loosely contained within the wall of its parent cell, colorless or slightly yellowish, subspherical, 15 to 20μ in diameter, its pronouncedly undulated wall loosely enveloping a subspherical protoplast 11 to 14μ in diameter.

Parasitic on nematodes it occurs in leaf mold in deciduous woods near Butternut, Wis.

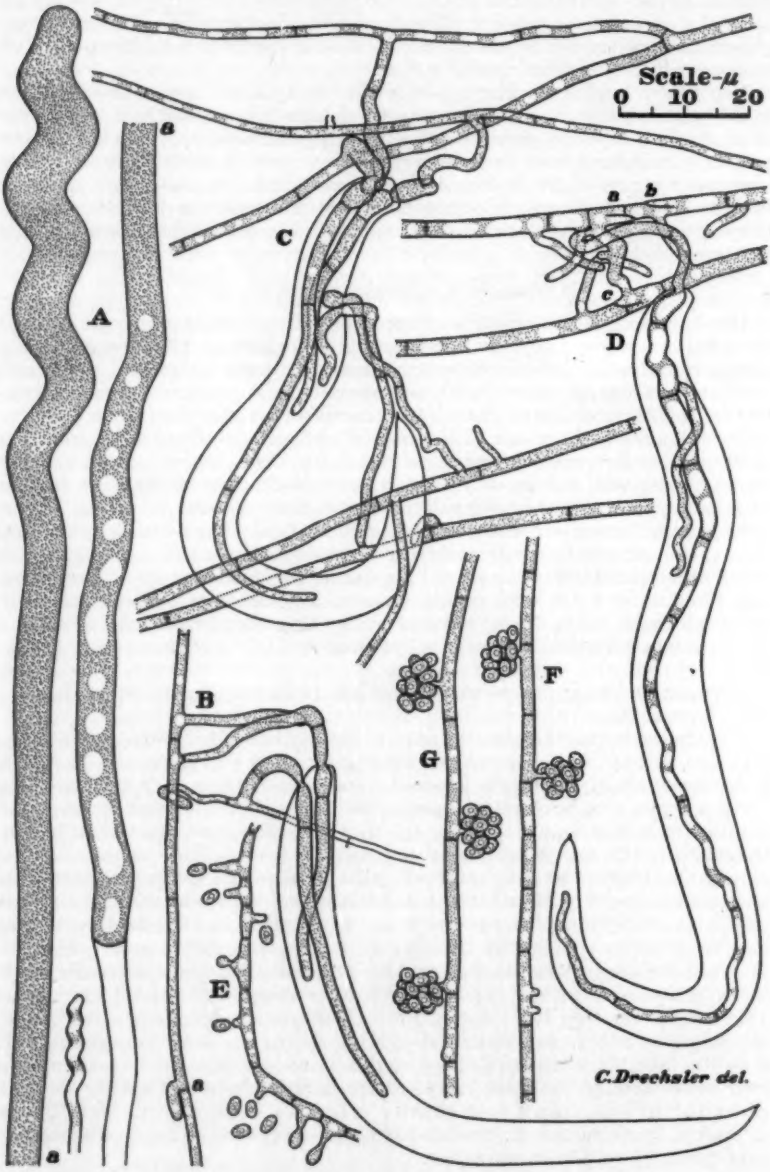


Fig. 3.—(See opposite page for explanation)

CEPHALOSPORIUM sp.

A fungus subsisting on eelworms, yet hardly deserving to be considered either predaceous or vigorously parasitic on these animals, was observed in a few nematode-infested agar cultures to which had been added some pinches of partly decayed tobacco leaves (*Nicotiana tabacum* L.) from a greenhouse near Beltsville, Md. In these cultures it apparently obtained its nourishment exclusively from specimens of *Plectus communis* Bütschli and *P. parvus* Bastian that had become disabled as a result of extensive infection by a protozoan endoparasite producing minute subspherical spores. When a disabled animal was halted near mycelial hyphae of the fungus, these hyphae would send out one or several branches, which soon perforated its integument and intruded a corresponding number of haustorial elements (Fig. 3, B, C, D). In most instances of plural penetration only one or two of the haustorial elements attained extensive development, apparently because the fleshy contents of the eelworm had already in large part been appropriated by the protozoan. Similar restriction of hyphal development within nematodes disabled and partly expropriated of contents by a protozoan parasite was noted earlier in my account (10) of the feebly predaceous *Tridentaria doedycoides* Drechsl.

Although its general habit recalls that of the more delicate species in the predaceous series of hyphomycetes, the fungus at present can neither be definitely assigned to nor excluded from that series. Its mycelial hyphae vary from 1 to 3μ in width. In addition to branches of indeterminate length, they bear here and there short spurlike branches that are often more or less appressed to the parent filament (Fig. 3, B, *a*). Ordinary cross walls occur in the mycelial hyphae at moderate intervals, and are supplemented by curiously oblique partial septa, which sometimes appear alone (Fig. 3, D, *b*), and at other times occur united to partial cross walls (Fig. 3, D, *a*, *c*). Infective branches are often noticeably stouter than the filaments from which they arise. The haustorial hyphae are often wider in their proximal portions than in their distal prolongations.

Hyaline ellipsoidal spores, commonly 2.5 to 3μ long and 1.5 to 2μ wide, are produced by the fungus on tapering branches, mostly 1.5 to 4μ long, and 1 to 2μ wide at the base. Owing, perhaps, to repeated disturbance by nematodes, these spores, when developed on the surface of a culture, show only a very promiscuous arrangement (Fig. 3, E); whereas in submerged and consequently better protected positions they are found in capitate clusters numbering ten to twenty individuals (Fig. 3, G, F). They have never been observed to infect nematodes, yet their small size would seem to make them incapable of giving rise to mycelia of such extent that disabled eelworms

---

Fig. 3.—Drawn to a uniform magnification with the aid of a camera lucida; × 1000 throughout. A, Sporiferous termination of a conidiophorous filament of *Meristacrum asterospermum*, showing its distal disposition in an extended helicoid spiral. B, Specimen of *Plectus communis* which, after its disablement by a protozoan parasite, is being invaded besides by two hyphae of *Cephalosporium* sp.; *a*, a short spurlike hyphal branch. C, Another disabled specimen of *P. communis*, penetrated by five hyphal branches of *Cephalosporium* sp. D, Specimen of *P. parvus* Bastian, disabled by protozoan parasite and then further invaded by a branching filament of *Cephalosporium* sp.; *a–c*, three oblique partial septa. E, Superficial hypha of *Cephalosporium* sp. with several spore-producing sterigmata. F, G, Submerged filaments showing clusters of spores at the tips of lateral sterigmata. (Owing to lack of space, *A* is shown in two parts, which are connected in *a*. The small sketch, in which the lower portions of the successive turns are stippled, is intended to show more clearly the direction of rotation in the helicoid termination.)

might become a likely source of nourishment. These circumstances suggest that the *Cephalosporium* stage present here may constitute an accessory reproductive phase in the development of the fungus, rather than its main conidial phase.

LITERATURE CITED

1. BAUNACKE, W. *Untersuchungen zur Biologie und Bekämpfung des Rübennematoden* Heterodera schachtii *Schmidt.* Arb. Biol. Reichsanst. Land- und Forstw. Berlin-Dahlem **11**: 185–288. 1922.
2. BERDAN, H. B. *Revision of the genus* Ancylistes. Mycologia **30**: 396–415. 1938.
3. BRAUN, A. *Über einige neue Arten der Gattung* Chytridium *und die damit verwandte Gattung* Rhizidium. Monatsb. Königl. Preuss. Akad. Wiss. Berlin **1856**: 587–592. 1856.
4. DANGEARD, P. A. *Les ancêtres des champignons supérieurs.* Le Botaniste **9**: 157–303. 1903.
5. DRECHSLER, C. *A new species of conidial phycomycete preying on nematodes.* Mycologia **27**: 206–215. 1935.
6. ———. *A new species of* Stylopage *preying on nematodes.* Mycologia **28**: 241–246. 1936.
7. ———. *New conidial phycomycetes destructive to terricolous Amoebae.* Mycologia **28**: 363–389. 1936.
8. ———. *Some hyphomycetes that prey on free-living terricolous nematodes.* Mycologia **29**: 447–552. 1937.
9. ———. *Five new Zoopagaceae destructive to rhizopods and nematodes.* Mycologia **31**: 388–415. 1939.
10. ———. *Three new hyphomycetes preying on free-living terricolous nematodes.* Mycologia **32**. 1940.
11. GOFFART, H. *Untersuchungen am Hafernematoden* Heterodera schachtii *Schm.* Art. Biol. Reichsanst. Land- und Forstw. Berlin-Dahlem **20**: 1–26. 1932.
12. KORAB, I. I. [*Results of a study of the beet nematode* Heterodera schachtii *Schm., according to investigations carried out at the nematode laboratory at Belozerkovsk. Ukrainian Research Institute for the sugar industry, Kiev*] **8**(16): 29–67. 1939. [In Russian with English summary.]
13. LINDNER, P. *Ein neuer Alchenpilz* Rachisia spiralis *n.g. n. sp.* Deutsche Essigindustrie **17**: 465–468. 1913.
14. MARIE, R. *Remarques sur le* Protascus subiliformis *à propos de la communication de M. E. Maupas.* Bull. Soc. Hist. Nat. l'Afrique du Nord **7**: 50–51. 1915.
15. MARTIN, G. W. *Two unusual water molds belonging to the family Lagenidiaceae.* Mycologia **19**: 188–190. 1927.
16. MAUPAS, E. *Sur un champignon parasite des* Rhabditis. Bull. Soc. Hist. Nat. l'Afrique du Nord **7**: 34–49. 1915.
17. MICOLETZKY, H. *Die freibelenden Süsswasser- und Moornematoden Dänemarks nebst Anhang über Amöbosporidien und andere Parasiten bei freilebenden Nematoden.* Danske Vid. Selsk. Skrifter Naturw. Math. (ser. 8) **10**: 57–310. 1925.
18. ROZSYPAL, J. *Houby na hád'átku řepném* Heterodera schachtii *Schmidt v moravských půdách* (*Pilze in Cysten von* Heterodera schachtii *Schmidt aus mährischen Rübenböden*). Věstn. Českosl. Akad. Zeměd. (Bull. Acad. Tchécosl. Agr.) **10**: 413–422. 1934.
19. SADEBECK, R. Pythium anguillulae aceti *nov. spec.* Bot. Centralbl. **29**: 318–319. 1887.
20. SCHENK, A. Achlyogeton, *eine neue Gattung der Mycophyceae.* Bot. Zeitung **17**: 398–400. 1859.
21. SCHERFFEL, A. *Endophytische Phycomyceten-Parasiten der Bacillariaceen und einige Monadinen.* Arch. Protistenk. **52**: 1–141. 1925.
22. SEURAT, L. G. *Émile Maupas.* Bull. Soc. Hist. l'Afrique du Nord **8**: 318–323. 1916.
23. SOROKINE, N. *Note sur les végétaux parasites des anguillulae.* Ann. Sci. Nat. Bot. (ser. 6) **4**: 62–71. 1876.
24. SPARROW, F. K. *Inoperculate chytridiaceous organisms collected in the vicinity of Ithaca, N. Y., with notes on other aquatic fungi.* Mycologia **25**: 513–535. 1933.
25. ———. *A contribution to our knowledge of the aquatic Phycomycetes of Great Britain.* Journ. Linn. Soc. London **50**: 417–478. 1936.
26. TOKUNAGA, T. *Notes on the Lagenidiaceae in Japan.* Trans. Sapporo Nat. Hist. Soc. **13**: 227–232. 1934.

BOTANY.—Atropellis *species from pine cankers in the United States.*[1] M. L. LOHMAN, Indiana University, and EDITH K. CASH, U. S. Bureau of Plant Industry. (Communicated by JOHN A. STEVENSON.)

INTRODUCTION

In various areas of the United States certain dermateaceous or tryblidiaceous fungi occur in association with twig or stem cankers of one or more species of *Pinus*, most frequently of species of hard or pitch pines (subgenus *Diploxylon* Koehne). These diseases, recently summarized by Boyce (1), have attracted the attention of pathologists only during the past 25 years.

The first was reported in 1921 by Weir (11), who described *Cenangium piniphilum* as a new species associated with stem cankers of *Pinus contorta* Loud. and *P. ponderosa* Lawson in Idaho and Montana. At that time Overholts (8) had observed cankered twigs of *P. rigida* Mill. in Pennsylvania, and later in the same State similar cankering of *P. pungens* Lamb., and considered the fungus associated to be a species of *Crumenula*, one possibly identical with *C. pinicola* (Rebent.) Karst., which has been reported (5, 7) as pathogenic to pines in Europe. Subsequently, Zeller and Goodding (13) described *Atropellis pinicola* as a new species in association with branch and stem cankers of several species of pine in the Pacific Northwest. They allied the fungus with *Scleroderris treleasei* Sacc. of Alaska in a new genus, *Atropellis*.

In 1932 specimens of *Atropellis* canker collected on *Pinus sylvestris* L. near Portsmouth, Ohio, and near Mount Alto, Pa., were received by the Division of Forest Pathology, U. S. Bureau of Plant Industry.[2] The following year an investigation of the disease was undertaken by the Civilian Conservation Corps, in cooperation with the Forest Service and the Division of Forest Pathology, and from the field surveys made approximately 500 collections of canker fungi accrued. The writers have had the opportunity to classify these specimens, which are largely from the Eastern and Southeastern States (2, 3). The present paper is concerned with the taxonomy of specimens representative of the various susceptible hosts in these areas, studied in comparison with authentic specimens of the canker fungi in the Western States.

[1] Received December 13, 1939.

[2] Collections by Dr. Curtis May and Dr. L. W. R. Jackson, respectively; also reported to the Division of Forest Pathology by Prof. J. S. Boyce as occurring on *P. sylvestris* and *P. resinosa* Soland. in Massachusetts and New Hampshire.

TAXONOMY OF SPECIES ON PINES

With respect to the previously mentioned so-called *Cenangium*, *Crumenula*, and *Atropellis* cankers in the United States, which are characterized by a grayish-green to blue-black coloration of the wood (Fig. 1, c) beneath each lesion (1), the causative fungi seem to be sufficiently closely related to be properly considered within a single genus. In some features, particularly the roughened exciple and the elongate, septate spores, the species here referred to *Atropellis* resemble those of *Crumenula* described as occurring on pines in Europe. The latter, however, are characterized by Rehm (9) and Lagerberg (7) as having the apothecium with circular opening, entire margin, pale hymenium, and long, fine excipular hairs. The American fungi differ from *Crumenula* in the furfuraceous exciple, stellate or irregularly lacerate aperture, and blue-black epithecium, as well as in the type of canker produced and the characteristic discoloration of the host tissue by the mycelium. In their clavate to elongate-fusoid ascospores the species are suggestive of *Scleroderris* as used by Karsten (6) and Rehm (9) but are dissimilar with respect to paraphyses, aperture, and exciple. It has been suggested that a possible relationship exists between these species and *S. bacillifera* (Karst.) Sacc., as mentioned by Zeller and Goodding (13). This fungus, however, as represented by Karsten's *Tympanis bacillifera* (Fung. Fenn. 756, Cent. 8, 1868, in the Farlow Herbarium, Harvard University) on bark of *Picea* ("granbark") has *smooth, patellate apothecia*, which conform in gross and microscopic features to the description by Karsten (6, cfr. Saccardo, Sylloge Fung. **8**: 595) and, except for arrangement of spores to that by Rehm (9). In the writers' preparation of F. Fenn. 756 ascospores are 0- to 5-septate, 22–36 by 3–3.5μ, subspirally overlapping, with three or four in the apex of the ascus.

It seems advisable, therefore, to recognize *Atropellis* as a distinct genus for the species associated with pine cankers in the United States, with certain revisions of the genus and species as described by Zeller and Goodding (13, p. 561) for pines.

Atropellis Zeller and Goodding, emend.

Apothecia erumpent, externally furfuraceous and brownish to black, fleshy coriaceous, single or cespitose, sessile to substipitate, cupulate to patellate, laciniately dehiscent, hymenium concolorous, bluish black or lighter; asci clavate, 8-spored; spores fusoid to narrow cylindrical-clavate, hyaline, continuous, then 1- to 3- (rarely 5-) septate; paraphyses hyaline, septate, simple or branched, exceeding the asci, end cells equal or slightly swollen, forming a colored epithecium, agglutinated below and granular

encrusted above by yellowish-brown, pinkish, or violaceous excretion; hypothecium typically thick, subtended by a hyaline medullary tissue; ectal layer dense, dark, furfuraceous.

Conidial stromata, where known, of similar habit, texture, and color; fertile cavities variable, usually coalescing, the pustules dehiscent by one or more papillulae; conidiophores simple or subverticillately branched; conidia minute, acrogenous, bacillar, continuous, hyaline.

In each of the following species the pinkish or violaceous material in and above the hymenial tissue of both conidial and apothecial fructifications is readily dissolved by sodium or potassium hydroxide solutions, which are immediately colored greenish or bluish. If a hydroxide solution is used as a swelling agent in microscopic preparations, the cytoplasm of young asci and ascospores appears greenish rather than hyaline. Overholts (8) describes this reaction in his account of the fungus associated with the canker of *Pinus pungens*, presumably the second of the following species.

Atropellis pinicola Zeller and Goodding Fig. 2, A–B

Zeller and Goodding (13) record *A. pinicola* on *Pinus contorta* Loud. and *P. lambertiana* Dougl. in Oregon, and on *P. monticola* D. Don. in Oregon, Washington, Idaho, and British Columbia. Zeller (12) also reports the species on *P. lambertiana* in California and on *P. strobus* L. in Oregon.

Atropellis pinicola differs from the three following species primarily in its longer and narrower spores, which Zeller and Goodding, upon the examination of numerous specimens, record as "32–63×1.5–3.5μ (average 40×2μ)," and in its more frequent occurrence on soft pines. Specimens examined by the writers have spores typical in size and shape, although not uniformly 1-celled as originally described, but frequently 2- to 4-celled, and occasionally 6-celled.[2] The paraphyses are septate, simple or forked, with the tip cells equal, or swollen and up to 4μ in diameter. The conidial fructifications and conidia observed conform to the descriptions under the succeeding species. (Cf. 12, p. 464.)

Atropellis tingens sp. nov. Fig. 1, B, C, F–H; Fig. 2, C–L

Apotheciis sessilibus vel substipitatibus, ex cortice erumpentibus, subglobosis dein patelliformibus, coriaceis, 2–3 mm diam., furfuraceis, atris, margine laciniato, hymenio atro-coeruleo; ascis clavatis, longe pedicellatis, octosporis, (70) 90–110 (150)×8–10 (14)μ; ascosporis 2–3-seriatis, anguste fusiformibus, rectis, curvatis vel sigmoideis, (20) 24–40 (46)×(2) 2.5–3.5 (4)μ; paraphysibus simplicibus ramosisve, apice incrustatis, epithecium atro-coeruleum formantibus; hypothecio brunneo, strato interiore hyalino, cortice denso, atro, rugoso; fructibus conidicis pustulatis, atris, furfuraceis, plicatis; conidiophoris ramosis, 35×1.5μ; conidiis bacillaribus, continuis, hyalinis, 4–8×0.5–0.7μ. Hab. in cortice ramorum vivorum Pini.

Apothecia sessile to substipitate, single or gregarious, erumpent through the bark of cankered areas, often concentrically arranged, subglobose when young, expanded to cup-shaped or patellate, contorted or compressed when crowded, opening by irregular splitting, coriaceous, 2–3 mm diam., exterior black, furfuraceous, margin laciniate, incurved, when dry often hysteroid

[2] Specimens examined: Oregon Agr. Coll. Herbarium no. 4877 (courtesy of S. M. Zeller); nos. 1304, 1635 (ex type), 1679, 1968, and 1969 in the herbarium of J. S. Boyce, Yale University; Forest Pathology nos. 86401–86405; Mycological Collections, U. S. Bureau of Plant Industry, nos. 66565–66567, 71100–71104.

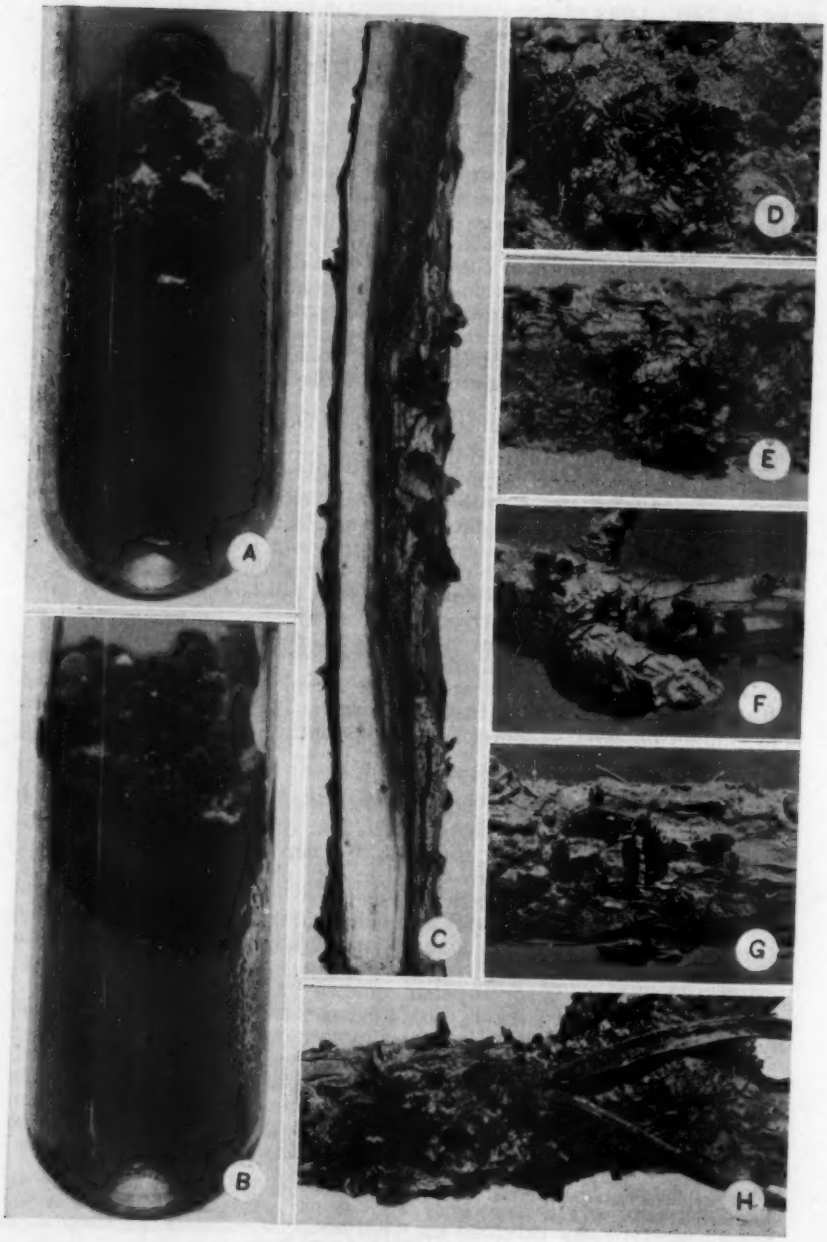


Fig. 1.—(See opposite page for explanation)

in form, hymenium blue-black, pruinose. Asci clavate, long-pedicellate, apex rounded, 8-spored, (70) 90–110 (150)×8–10 (14)μ; spores irregularly 2–3 seriate in the upper part of the ascus, slender fusiform, broadest near the apex and tapering below, straight, curved or sigmoid, hyaline, continuous then 1–3 (rarely 4–5) septate, (20) 24–40 (46)×(2) 2.5–3.5 (4.0)μ; paraphyses sometimes simple, more frequently branched and slightly thickened at the tips, septate, subhyaline, granular-encrusted, forming a dense purplish- or bluish-black epithecium. Hypothecial layer 20–25μ thick, brown; underlying tissue of fine, loosely interwoven, hyaline or subhyaline hyphae, forming a layer 70–110μ thick; cortex 30–100μ thick, very dense, black, roughened on the outer surface by clumps of thick-walled, brown, closely septate hyphae. Conidial fructifications pustulate, erumpent, black, furfuraceous as in the apothecia, irregularly chambered or folded, the folds lined with branched conidiophores 35×1.5μ; conidia borne at the tips of the branches, bacillar, continuous, hyaline, 4–8×0.5–0.7μ.

On cankered twigs, branches and small stems of *Pinus banksiana* Lamb., *P. caribaea* Morelet, *P. clausa* (Engelm.) Sarg., *P. densiflora* Sieb. & Zucc., *P. echinata* Mill., *P. nigra* Arn., *P. pinaster* Ait., *P. pungens* Lamb., *P. resinosa* Soland., *P. rigida* Mill., *P. rigida* var. *serotina* (Michx.) Loud., *P. strobus* L. (infrequent), *P. taeda* L. and *P. virginiana* Mill., from New Hampshire to Florida, west to Ohio and Arkansas (2, 3). Type specimen: *Diller* 24 on *Pinus rigida*, Camp Roosevelt, George Washington National Forest, Va., June 12, 1933.[4] All of the specimens on *Pinus strobus* were obtained near Mount Solon, Va.

The ascospores of this species are regularly shorter and broader than those of *Atropellis pinicola*, averaging approximately 30×3μ, but of the same degree of variation. With respect to a single apothecium, spores in general are less variable in width than in length. When relatively broad ascospores are encountered, they are of the shape characteristic of the species and average considerably longer than those of the next succeeding species.

The specimens examined show that apothecia with mature spores may be found throughout the year, as Zeller and Goodding note for *Atropellis pinicola*. Yet much sterile material is encountered among samples from the surveys and among the writers' casual collections made during all seasons of the year. Possible perennial sporulation on living or weakening twigs and stems is suggested by the arrangement of the apothecia and degrees of development on cankers of long standing.

While this species is suggestive of *Atropellis pinicola* in the shape and arrangement of the ascospores and of the following species in its general occurrence on hard, rather than soft, pines, it is clearly intermediate to the two with regard to spore size.

[4] The type and other respresentative specimens are deposited in the Mycological Collections, U.S. Bureau of Plant Industry; portions of the type and several other collections are also in the Farlow Herbarium of Harvard University and the herbaria of the New York Botanical Garden and the University of Michigan.

Fig. 1.—A–B, Seven-weeks-old cultures of *Atropellis* on malt agar medium, kept at room temperature: A, *Atropellis arizonica* from *Pinus ponderosa;* B, *A. tingens* reisolated 21 months after *Pinus echinata* was inoculated with a culture from *P. caribaea.* C–H, *Atropellis* on various pines: C, *A. tingens* on *P. pungens*, North Carolina; D, *A. piniphila* on *P. ponderosa*, Idaho; E, *A. arizonica* on *P. ponderosa*, Arizona; F, *A. tingens* on *P. sylvestris*, Ohio; G, *A. tingens* on *P. taeda*, Virginia; H, *A. tingens* on *P. pinaster*, North Carolina. Figures A–H, ×2; all photographic negatives by M. L. F. Foubert.

The species grows very slowly in cultures held at room temperature, producing uneven, elevated, black, compacted or loosely stromatic surface mats of irregular outline and with scattered and marginal, fine grayish to violaceous tomentum on potato-dextrose and malt agar media, and less erumpent colonies with black subsurface mycelioid margins on corn meal agar. Identical colonies were obtained from plantings of infected wood of various species of pines. The conidial stage developed in irregular, convoluted areas, was observed in isolations from *Pinus banksiana* Lamb., *P. caribaea* Morelet, *P. echinata* Mill., *P. pinaster* Ait., and *P. pungens* Lamb.,

Atropellis piniphila (Weir) comb. nov. Fig. 1, D; Fig. 2, M

As mentioned above Weir (11) reports this fungus as *Cenangium piniphilum* on *Pinus contorta* and *P. ponderosa* in Montana and Idaho. More

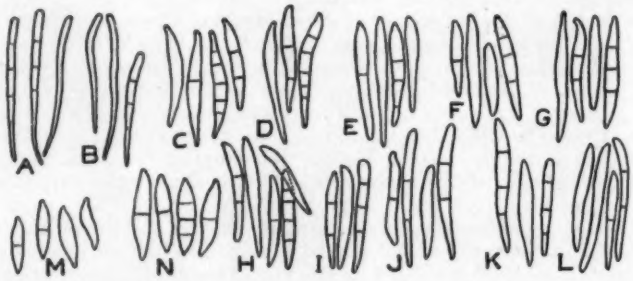


Fig. 2.—Ascospores of four species of *Atropellis;* ×500. A, *A. pinicola* on *Pinus monticola*, Oregon; B, same on *P. contorta*, Oregon; C–L, *A. tingens* on various pines in the Eastern States (*Pinus virginiana, taeda, pungens, caribaea, sylvestris, banksiana, echinata, rigida, resinosa,* and *strobus,* respectively); M, *A. piniphila* on *Pinus contorta* (type specimen); N, *A. arizonica* on *Pinus ponderosa.*

recent accounts (1, 12) indicate its further occurrence in the Pacific Coast States on these hosts and on *P. albicaulis* Engelm., and (4) in Arizona and New Mexico on *P. ponderosa.* Specimens examined in the present study add other hosts and extend the range of the species to New Mexico and stations in the Southeast.[5] The species occurs on both soft and hard pines but infrequently on the former.

The apothecia are as characterized for the genus, with the hymenium brownish to black, averaging somewhat larger than those of the two preceding species. The asci are longer and broader, measuring (100) 120–135 (170) ×10–15μ, and the tendency for the spores to be clumped in the upper end also obtains in this species, with the upper two to six spores biseriate overlapping. Paraphyses are septate, simple or branched, with the tip cells

[5] Specimens examined: *Weir* 2631 (locality unknown: probably Dakotas), on *Pinus banksiana* Lamb.; *Weir* 2624 and 2625 (Idaho), 2626 (Montana), 2627 (Washington), and *Forest Pathology* 14973 (type) and 15532 (Idaho), all on *P. contorta* Loud; *Weir* 2633 (Oregon), *P. jeffreyi* "Oreg. Com."; *Weir* 2628 (Idaho), *F. P.* 89367 *Gill & Ellis* (New Mexico), *P. ponderosa* Lawson; *Weir* 2630 (Alabama), *P. taeda* L.—all in Mycological Collections, U.S. Bureau of Plant Industry; *Boyce* 766 (ex-type), and 1659 (Idaho), *P. monticola* D. Don.—Herbarium of J. S. Boyce; *Diller* 311 (Tennessee), *P. virginiana* Mill.—courtesy of J. D. Diller.

equal or swollen. The hymenium in section shows the purplish tints characteristic of species of this group. Ascospores are elliptical-fusoid, with ends rather acute, straight or subsigmoid, and measure (14) 16–22 (24)×(3.5) 4–5 (5.5)μ, averaging 18×5μ in the type specimen. While Weir describes and illustrates the spores as 1-celled, 1- and 2-celled spores occur in half of the specimens listed herein, including the type. The conidial stage observed in association with apothecia (Boyce number 1659) is morphologically identical with that of *A. tingens*.

Sydow and Petrak (10) determine this fungus as *Cenangium farinaceum* (Pers.) Rehm, which occurs on branches of *Pinus sylvestris* in Europe, making particular note of the coloration in the hymenium ("Paraphysen") and epithecium. Rehm (9) notes that in this respect *C. farinaceum* differs from other species of *Cenangium*. The accounts, however, do not indicate that the European fungus is pathogenic or that it discolors the wood. On the basis of Rehm's description *C. farinaceum* has smaller asci and shorter and broader, 1-celled spores, which have obtuse rather than acute ends. Whatever the relationship between these fungi may be, the American specimens can not be identified as *Peziza pinicola beta caespitosa* of Fries (Syst. Myc. **2**: 113; *Peziza farinacea* Pers., Syn. Fung., p. 672), which in the specimen distributed by Fries ("294. *Peziza farinacea* b. Syst. Myc." in the Farlow Herbarium, Harvard University), shows numerous flattened, smooth, black and shining apothecia up to 0.6 mm broad when dry, occurring singly or clustered on a large sheet of bark sufficient to indicate that fruiting was not associated with a canker condition. Therefore, the synonymy that Sydow and Petrak suggest is considered untenable.

Atropellis arizonica sp. nov. Fig. 1, A, E; Fig. 2, N

Apotheciis substipitatibus, ex cortice erumpentibus, subglobosis dein expansis, coriaceis, atris, 1.2–2.5 mm diam., furfuraceis, margine undulato, lacinato, incurvato, hymenio pruinoso, atro-coeruleo; ascis cylindrico-clavatis, apice obtusis (90) 100–120×9–14μ; ascosporis 2-3-seriatis, elliptico-fusoideis, rectis vel subsigmoideis, continuis vel 1-3-septatis, (20) 24–28 (32)×(4) 4.5–6 (7)μ; paraphysibus filamentosis, septatis, ramosis; hypothecio brunneo; strato interiore hyalino, cortice crasso, atro, rugoso; fructibus conidicis pustulatis, nigris; conidiophoris ramosis, 12–20×2μ; conidiis bacillaribus, hyalinis, continuis, 4–6×1–1.5μ. Hab. in cortice ramorum vivorum Pini.

Apothecia substipitate, erumpent singly or in groups of two to three, scattered over bark of cankered areas of the host, subglobose when young, then expanded and patellate, sometimes irregularly contorted and compressed when crowded, leathery, black, 1.2–2.5 mm diam., exterior furfuraceous, margin undulate, laciniate, incurved when dry, hymenium pruinose, blue-black. Asci cylindrical-clavate, obtuse at the apex, gradually attenuated toward the base, 8-spored, (90) 100–120×9–14μ; spores irregularly 2-3-seriate in the upper part of the ascus, 1-2-seriate below, elliptic-fusoid, straight or subsigmoid, tapering at both ends, continuous to 1-3-septate, equal or slightly constricted at the central septum, (20) 24–28 (32)×(4) 4.5–6 (7)μ; paraphyses filamentous, septate, branched above, the tip cells equal or swollen, dilute pinkish in mass, covered by a dense blue-black epithecium. Hypothecium brown, 45–65μ thick; inner layer of tissue 100–150μ thick, of loosely interwoven, subhyaline hyphae; cortex 100–250μ thick, black, dense, exterior roughened and covered with loose clumps of

dark, closely septate hyphae. Conidial fruits pustulate, black, furfuraceous as in the apothecia; conidiophores simple or branched, pale violaceous in mass, 12–20×2μ; conidia bacillar, hyaline, continuous, 4–6×1–1.5μ.

On stems of *Pinus ponderosa* Lawson, Hospital Flat, Safford, Ariz., September 22, 1934, D. J. Stouffer.

This species is known only from the locality of the type specimen, which was obtained at an elevation of 9,000 feet. It is closely allied with *A. piniphila* but has longer and broader spores, in their form suggestive of certain species of *Crumenula* on pines in Europe. In cultural aspects the species resembles *A. tingens*. The conidial stage was obtained in cultures from isolated groups of ascospores discharged upon plates of nutrient agar.

SUMMARY

The genus *Atropellis* is revised to include along with *A. pinicola* Zeller and Goodding, of the Pacific Northwest, two new species, namely, *A. tingens* and *A. arizonica*, and *Cenangium piniphilum* Weir, all of which cause characteristic cankers of pines. Of these *A. tingens* is of widest occurrence, on various species of native and introduced pines in the eastern half of the United States, and *A. arizonica* is most limited in distribution, being known only from the type locality, Safford, Arizona. Each of the species produces a localized, dark stain of the wood in cankered twigs or stems.

LITERATURE CITED

1. Boyce, J. S. *Forest pathology*, 600 pp., illus. New York, 1938.
2. Diller, J. D. *The* Atropellis *canker of eastern pines.* Service Letter, Pennsylvania Dept. Forests & Waters, ser. 5, no. 46, pp. [2–3]. 1934.
3. ———. *The* Atropellis *canker of eastern pines.* Plant Dis. Report. **19**: 17. 1935.
4. Ellis, D. E. *Conifer diseases hitherto unreported from the Southwest.* Plant Dis. Report. **23**: 341. 1939.
5. Jørstad, I. *Innberetning fra statsmykolog Ivar Jørstad om soppsykdommer på skogtraerne i årene 1926–1930. Beretning om det Norske Skogvesen for 1930, Skogdirektøren, Oslo, pp. 78–96. 1931.* Rev. Appl. Myc. **11**: 136–137. 1932.
6. Karsten, P. A. *Mycologia Fennica. Pars prima, Discomycetes.* Bidr. Finl. Nat. Folk **19**: 1–264. 1871.
7. Lagerberg, T. *Studier öfver den norrländska tallens sjukdomer, särskildt med hänsyn till des föryngring.* Medd. Stat. Skogsförsöksanstalt **9**: 135–170, illus. 1912.
8. Overholts, L. O. *Mycological notes for 1925.* Mycologia **18**: 179–184, illus. 1926.
9. Rehm, H. *Ascomyceten: Hysteriaceen und Discomyceten in Rabenhorst's Kryptogamen-Fl.*, ed. 2, Bd. 1, Abt. 3, 1270 pp., illus. 1896.
10. Sydow, H., and Petrak, F. *Ein Beitrag zur Kenntnis der Pilzflora Nordamerikas, insbesondere der nordwestlichen Staaten.* Ann. Myc. **20**: 178–218. 1922.
11. Weir, J. R. Cenangium piniphilum *n. sp., an undescribed canker-forming fungus* on Pinus ponderosa *and* P. contorta. Phytopath. **11**: 294–296, illus. 1921.
12. Zeller, S. M. *Some miscellaneous fungi of the Pacific Northwest.* Mycologia **27**: 449–466, illus. 1935.
13. ——— and Goodding, L. N. *Some species of* Atropellis *and* Scleroderris *on conifers in the Pacific Northwest.* Phytopath. **20**: 555–567, illus. 1930.

ENTOMOLOGY.—*New genera and species of lady-beetles related to* Serangium *Blackburn (Coleoptera: Coccinellidae).*[1] EDWARD A. CHAPIN, U. S. National Museum.

This paper has been prepared primarily to supply names for certain species of coccinellid beetles of economic importance. In the course of the work dissections of representatives of a great many genera were made, and it became evident that in many places the accepted classification of the family is faulty. More attention must be paid to the structures of the head and abdomen before a system can be outlined that will be justified by the morphology of the species involved. The division of the family into its major groups will, I believe, be based mainly on the structure of the mandible. Such a system was suggested in 1843 by Redtenbacher.[2]

Thanks are due to Miss Hazel Bowen, who has prepared the figures illustrating the essential characters of the genera discussed.

The genera and species considered in this paper form a very compact group within the family Coccinellidae. This group is the Oeneini of Casey, 1899, minus the genus *Oeneis* Mulsant, 1850. As the species placed in *Oeneis* must be associated with *Cryptognatha* Mulsant, 1850, and not with *Delphastus* Casey, 1899, and as the name *Oeneis* is not available for use in the Coccinellidae because of its prior use in Lepidoptera by Hübner, the tribal name Oeneini must be abandoned. It seems undesirable at present to propose a new name in view of our lack of exact knowledge of the structure of most of the small Coccinellidae.

It is advisable here to discuss certain generic segregates that have been presumed to be related to this group:

Lioscymnus Champion, 1913, is determined, after an examination of a paratype of the type species, to be a synonym of *Delphastus*.

Delphastobia Casey, 1924, is determined, after examination of the type species and specimen, to be a chrysomelid related to or belonging to the genus *Lamprosoma*.

Delphastopsis Casey, 1924, is determined, after examination of the type species and specimen, to be close to and possibly a member of the genus *Scymnillus*.

Semichnoodes Weise, 1892, is, according to notes by Sicard, 1909, not related to *Serangium*.

Serangium monticola Sicard, 1909, is, according to the original description and figure, not related to *Serangium*.

The species belonging to this group have the following characters in com-

[1] Published by permission of the Secretary of the Smithsonian Institution. Received January 15, 1940.

[2] *Tentamen dispositionis generum et speciorum coleopterorum . . .*, 32 pp., Vidobonae, 1843. Reprinted in Germar's Zeitsch. Ent. 5: 113–132. 1844.

mon: Form very compact; head convex in front; antennae with the terminal segment spatulate and very long in comparison with other segments; pronotum finely margined throughout; prosternum strongly developed anteriorly as a plate protecting the mouth parts when head is in position of repose, notched on each side near lateral margins for the reception of the antennae; elytral epipleura moderately broad, with cavities for the reception of the tips of the middle and posterior femora; legs received in deep cavities on under side of body, those for the front legs being on the prosternum, for the middle legs on the suture separating the meso- and metasternum and for the hind legs mostly on the first abdominal sternite; femora broad and flat, completely concealing the tibiae when legs are retracted; abdomen with five visible sternites, the second, third, and fourth being quite short in comparison with the first and fifth.

After the elimination of the genera mentioned above, there remain two described genera having the characteristics listed in the preceding paragraph and two as yet unnamed. These four may be separated in the following manner:

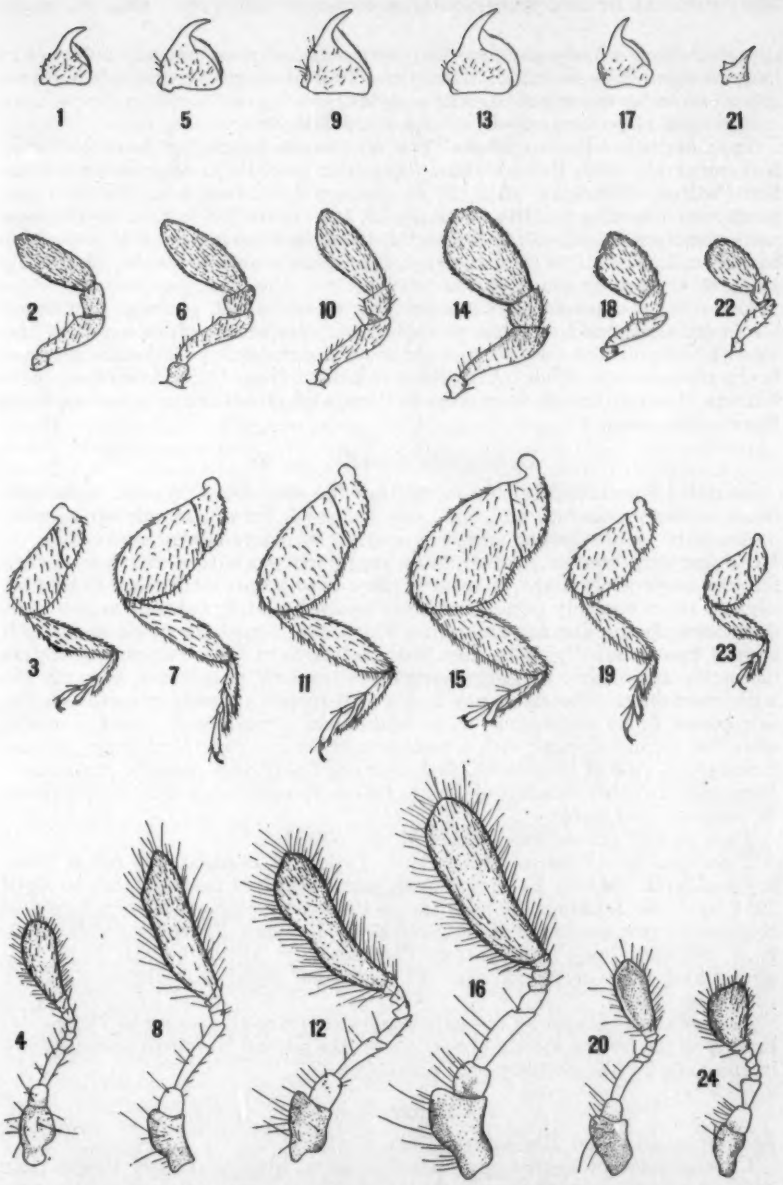
1. Antennae 8-segmented; size large (length 2–2.5 mm); middle and hind tibiae not angulate externally; Oriental region.....*Catana*, new genus
   Antennae 9-segmented; size small to medium (up to 2 mm).....2
2. Middle and hind tibiae slender, not angulate externally; size medium (1.5–2 mm); Oriental, Ethiopian, and Australian regions.....
   .....*Serangium* Blackburn
   Middle and hind tibiae angulate externally.....3
3. Third segment of antennae obtriangular, twice as wide at apex as fourth segment; tibiae without teeth at apex of angulation; size small (about 1 mm); Ceylon.....*Serangiella*, new genus
   Third segment of antennae cylindrical, not much wider at any point than fourth; tibiae with usually two denticles at angulation of tibiae; size small to medium (0.8–1.5 mm); New World....*Delphastus* Casey

Delphastus Casey, 1899

While it is not possible at present for me to give a key to all the species, it is desirable to give names to two species that are frequently submitted for identification. The essential characters of the type species of the genus, *Delphastus pusillus* (LeConte), are illustrated in Figs. 1–4.

Delphastus nebulosus, n. sp.

Length 10 mm, width 0.8 mm, altitude 0.5 mm. Pale yellow-brown, legs whitish, elytra each with a single basal castaneous spot of indefinite extent. Integuments shining. Head not visibly punctured except for a very few minute setigerous punctures. Scutellum very small, not visibly punctured. Elytra without visible punctures, but with pellucid dots grouped along the suture and lateral margin and on apical portion. Two or three setae occur on each elytron in the region of the humeral callus, and a few very short setae along the lateral margin toward the apex; otherwise the elytra are glabrous. The dark spot extends along base from near scutellum to beyond humeral callus and backward to just beyond basal third. The margin of the spot is not sharp but the area covered is fairly constant in the series of specimens examined. Under parts not visibly punctured except for the apical abdominal



Figs. 1–4.—*Delphastus pusillus* (LeConte): 1, Mandible; 2, maxillary palpus; 3, hind leg; 4, antenna. Figs. 5–8.—*Catana clauseni*, n. sp. Figs. 9–12.—*Catana parcesetosa* (Sicard). Figs. 13–16.—*Catana spilota* (Weise). Figs. 17–20.—*Serangium maculigerum* Blackburn. Figs. 21–24.—*Serangiella flavescens* (Motschulsky).

sternite, which is finely and densely punctured and conspicuously pubescent. Femora shining, impunctate. Middle and hind tibiae with two small denticulations on outer margin at apex of angulation.

Type and 17 paratypes.—U.S.N.M. no. 53941.

Type locality.—Puerto Rico. Type and seven paratypes from Villalba, November 15, 1932, R. G. Oakley (San Juan no. 3195); six paratypes from Rio Piedros, March 19, 1913, T. H. Jones (P.R.S.G.A.Acc. 274–13); one paratype from same locality, January 25, 1914 (P.R.S.G.A.Acc. 16–14); one paratype from Barceloneta, March 22, 1932 (San Juan no. 2069); one from Santurce, April 1, 1932 (San Juan no. 2121); and one from Ponce, March 13, 1933, R. G. Oakley (San Juan no. 3796).

Remarks.—*D. nebulosus* is most closely related to *D. pallidus* (LeConte) but is distinguished from that species by the spot on the elytron and by the smooth and polished side pieces of the metathorax (in *D. pallidus* sclerites are finely alutaceous). While *D. pallidus* is known from Cuba as well as from Florida, it is not known from Puerto Rico, and *D. nebulosus* is known from Puerto Rico only.

Delphastus collaris, n. sp.

Length 1.3 mm, width 1.0 mm, altitude 0.5 mm. Deep piceous; male with head, entire prothorax, and legs pale yellowish brown, female with head, under part of prothorax, and legs somewhat paler. Integuments shining. Head not very convex, sparsely and irregularly set with a mixture of very fine and moderately coarse punctures, some of which are setigerous. Pronotum slightly more coarsely punctured, very sparsely hairy, anterior angles bent down outside the fine marginal line, which cuts across the angle and which is very fine anteriorly. Scutellum with only two or three punctures. Elytra distinctly and rather densely though not coarsely punctured, sparsely set with erect hairs. Metasternum finely and rather sparsely punctured, the side pieces finely alutaceous. First abdominal sternite punctured as metasternum, second sternite with a complete, third and fourth sternites with an incomplete, row of punctures, fifth sternite finely and sparsely punctured. Femora not visibly punctured. Denticles on tibiae elongated into crests as in *D. pusillus* (LeConte).

Type and 37 paratypes.—U.S.N.M. no. 53940.

Type locality.—Paraiso, Canal Zone. Type and 28 paratypes taken January to March 1911 by E. A. Schwarz; nine paratypes taken March to April 1911 by A. H. Jennings. In addition to the type material I have referred to this species two specimens from Porto Bello, Panama, February 15–24, 1911, E. A. Schwarz; one specimen from Panama City, April 30, 1911, A. H. Jennings; and five specimens from El Cermeno, April–May 1938, J. Zetek (Zetek no. 4401).

Remarks.—This species is easily separated from all species of *Delphastus* known to me by the strong punctures on the second to fourth sternites and in the male by the entirely pale prothorax.

Catana, n. gen.

Serangium auct. nec Blackburn, 1889, p. 187.

Coccinellidae of nearly hemispherical form, always slightly longer than greatest width, altitude greater than half the transverse diameter (the three dimensions approaching the ratio 8:7:4). Head convex, eyes relatively coarsely faceted, very slightly emarginate adjacent to antennal sockets, without canthus; distance between inner margins of antennal sockets equal

to three-fourths distance between eyes; antennal sockets moderately large, with beaded margin, the marginal bead continuous around the clypeus but finer across anterior margin of clypeus; clypeus transverse anteriorly with rounded angles; antenna 8-segmented, first segment stout, second globular, third elongate, subcylindrical, as long or slightly longer than fourth to seventh combined, fourth longer than fifth, sometimes showing the beginning of a division and therefore morphologically equal to fourth and fifth combined, fifth to seventh short and subequal, eighth long, broad and thin, setigerous, longer than second to seventh combined; mandible with slender apical portion somewhat curved, prostheca conspicuous; maxillary palpus with terminal segment not strongly inflated. Pronotum short, strongly transverse, anterior angles acute and prominent, posterior angles acute, marginal line complete, basal margin slightly sinuate near scutellum. Prosternum strongly developed and subtruncate anteriorly, lateral portion deeply notched for reception of antennae, the median portion strongly bicarinate, the carinae strongly divergent anteriorly. Posterolateral portions deeply excavate for the reception of the front legs. Mesosternum very short. Metasternum long. All coxae widely separated, the hind coxae especially so. Femora broad, tibiae rather slender, tarsi with four distinct segments, the third about one-third length of fourth. Claws broadly toothed at base. Scutellum small, triangular. Elytra with broad, somewhat concave epipleura, which are impressed deeply for reception of apices of femora. Abdomen of five visible sternites, first and fifth long, second to fourth very short. See Figs. 5–16.

Genotype.—Catana clauseni, n. sp.

In addition to the type species, I refer the following previously described species to *Catana*: *Serangium parcesetosum* Sicard, 1929, from India, and *Serangium spilotum* Weise, 1913, from Luzon, Philippines.

These three species may be distinguished in the following manner:

1. Uniform pale yellow-brown ..... *parcesetosa* (Sicard)
   Upper parts deep piceous, elytron with a large castaneous spot 2
2. Pronotum rather densely hairy at sides; spot on elytron elliptical .....
   ..... *spilota* (Weise)
   Pronotum sparsely but evenly hairy; spot on elytron reniform .....
   ..... *clauseni*, n. sp.

Catana clauseni, n. sp. Figs. 5–8

Cryptognatha sp. Clausen and Berry, 1932, pp. 36–40.

Length 2.3 mm; width 2 mm; altitude 1.14 mm. Head, legs, under parts, and a large reniform spot on each elytron bright castaneous, pronotum, scutellum, and rest of elytron deep piceous. Integuments shining. Front of head minutely and sparsely punctulate, vertex slightly more densely so, a fine hair arising from each puncture. Pronotum more coarsely punctured than head, the punctures sparsely and irregularly set, each furnished with a fine and moderately long hair. Scutellum with a very few fine punctures. Elytra very minutely and sparsely punctulate on disks, slightly more coarsely so on apical third and each with a regular row of fine punctures that is parallel to and near lateral margin, each puncture of the row bearing a short seta. The castaneous reniform spot on each elytron is large, commencing near scutellum and reaching to about apical fourth, its concave margin toward the suture. The spots are variable in size, but in no specimen do they coalesce either anteriorly or posteriorly. Under parts shining and minutely and sparsely punctulate except for the side pieces of the metaster-

num, which are strongly alutaceous, and for the apical abdominal sternite, which is rather densely punctured and furnished with rather long hairs. Femora finely and rather densely punctulate, hairy, strongly margined on basal half of posterior border. Tibiae slender.

Type and 23 paratypes.—U.S.N.M. no. 53942.

Type locality.—Medan, Sumatra. Other localities: Kuala Lampur, Federated Malay States, and Cuba in the West Indies where the species has been introduced.

Remarks.—The material before me consists of 24 specimens from Medan, seven from Kuala Lampur, both lots collected by C. P. Clausen, and 27 specimens from Cuba, five from Santiago de las Vegas, August 20, 1934, A. R. Otero (E.E.A. Cuba, Ent. no. 10350), and 22 from Camito, Province Habana, May 17, 1938, P. A. Berry. As the species was introduced into Cuba in 1930, the 1938 collection would indicate that it is firmly established on the island. Recently the species has been planted at Nassau, Bahamas, but no recoveries have so far been made from that locality.

Catana spilota (Weise) Figs. 13–16

Serangium spilotum Weise, 1913, p. 241.

The national collection contains a series of 23 specimens collected in May 1911 on Negros Island, Philippines, by C. V. Piper. Although the type locality of this species is Luzon, I can see no reason to doubt the specific identity of the Negros specimens.

Catana parcesetosa (Sicard) Figs. 9–12

Serangium parcesetosum Sicard, 1929, p. 184.

Sixty specimens of this species from India are in the collection. Most of these are labeled "Panjab and U Provinces, VI–X, India, R. S. Woglum"; some carry the additional data "predaceous on Aleyrodidae, Saharanpur, India, R. S. Woglum," and two were taken at Mangalore by J. C. Bridwell. Except for a slight variation in size, the specimens are remarkably uniform.

Serangium Blackburn, 1889

Several species of this genus were studied in connection with the species now placed in *Catana* and those that appear to be new are described in the following pages. For convenience, a key to the new ones, together with two well-known Australian species, is given. For illustration of the salient characters, *Serangium maculigerum* Blackburn was selected, and Figs. 17–20 refer to this species.

Grandi (1914) made a very careful study of an African species, *Serangium giffardi* Grandi, and gave a detailed description with excellent figures of the adult, larva, and pupa. With this evidence there can be no doubt concerning the occurrence of the genus in Africa. It is unfortunate that Grandi was not permitted to dissect a specimen of *Semichnoodes kunowi* Weise and so demonstrate the true affinities of that genus.

1. Elytra densely hairy; front femur alutaceous; side pieces of metasternum roughly sculptured; abdominal sternites strongly punctured..... .....*hirtuosum* Blackburn

Elytra very sparsely hairy, usually with a few setae at base and along margins.....2

2. Prosternum alutaceous 3
   Prosternum shining, indistinctly punctured 4
3. Second to fourth abdominal sternites finely strigillose; metasternum without a triangular alutaceous area at side ..... *maculigerum* Blackburn
   Second to fourth sternites smooth and polished; metasternum with lateral triangular alutaceous area ..... *metasternalis*, n. sp.
4. Outer face of front femur shining, not evidently alutaceous, pronotum entirely pale ..... *comperei*, n. sp.
   Outer face of front femur strongly alutaceous; pronotum at most with pale front angles 5
5. Abdominal sternites highly polished, without punctures except along apical margin of fifth ..... *bakeri*, n. sp.
   Abdominal sternites very sparsely but distinctly punctured except fifth, which is rather densely punctured at middle 6
6. Elytra noticeably and rather strongly punctured ..... *japonicum*, n. sp.
   Elytral punctures visible only with high magnification ..... *luzonicum*, n. sp.

Serangium japonicum, n. sp.

Length 2 mm; width 1.5 mm; altitude 0.9 mm. Deep piceous, head, flanks of pronotum narrowly, and legs pale castaneous. Integuments shining. Head with a few distinct punctures more or less definitely grouped in two patches, one on each side of the median line, sparsely hairy. Pronotum finely, sparsely and very irregularly punctured. The punctures near the median line, which is narrowly impunctate, somewhat coarser than those near the lateral margin, surface sparsely hairy. Scutellum occasionally with one or two punctures, usually impunctate. Elytra moderately coarsely, densely, and evenly punctured, except that the punctures near the apical angles are somewhat coarser than the others. Elytra without vestiture except for a submarginal row of short setae. Epipleura finely punctured and sparsely hairy. Prosternum somewhat rough, meso- and metasternum polished with a few fine punctures, side pieces of metasternum alutaceous. Abdominal sternites sparsely punctured except last, which is densely punctured and finely pubescent. Front femora strongly alutaceous, middle and hind femora very sparsely punctured and finely hairy.

Type and 15 paratypes.—U.S.N.M. no. 53943.

Type locality.—Japan. Type and seven paratypes from Yokohama, where they were found feeding on *Ceroplastes rubens* by S. I. Kuwana; three paratypes labeled "Japan. Koebele" (Koebele Note no. 1263); and five paratypes from Nagasaki, taken May 20, 1922, feeding on aleurodid eggs by T. Ishii.

In addition to the type material, I ascribe to this species a single specimen from Nanking, Kiangsu Province, China, taken August 15, 1919, by H. F. Loomis.

Serangium comperei, n. sp.

Length 1.7 mm; width 1.3 mm; altitude 1.1 mm. Pale yellow-brown, pronotum sometimes infuscate at base (female?), elytra piceous except for narrow basal, humeral, and apical margins, which are yellow-brown. Integuments shining. Head finely and very sparsely punctured, the punctures bearing fine, moderately strong setae. Pronotum sparsely and irregularly punctured, the punctures of two sizes, the larger ones bearing fine setae. Scutellum not visibly punctured. Elytra without visible punctures except

for a very few in the scutellar region, and one or two setigerous punctures near humeral callus. Epipleura finely and sparsely hairy. Prosternum finely and moderately densely punctured and hairy, meso- and metasternum and abdominal sternites one to four shining, without visible punctures, fifth (apical) sternite shining and impunctate laterally, finely and densely punctured and hairy at middle. Femora shining and not visibly punctured.

Type and four paratypes.—U.S.N.M. no. 53944.

Type locality.—Fiji Islands. A series of five specimens was taken at the type locality by George Compere in October or November 1899.

Serangium bakeri, n. sp.

Length 1.4 mm; width 1.1 mm; altitude 0.6 mm. Under parts, head, and sometimes portion of pronotum castaneous, legs slightly paler than sternites, upper parts generally deep piceous. Head very finely and sparsely punctured. Pronotum with a few setigerous punctures, mostly on disk. Scutellum not visibly punctured. Elytra without visible punctures, with a few long setae near scutellum, humeral callus, along basal half of suture, and on lateral margin near apex. Epipleura almost impunctate, apparently not setose. Prosternum very finely and sparsely punctured, mesosternum finely punctate and rather densely hairy, metasternum with setigerous punctures adjacent to mesosternum at middle and on the median portion, side pieces of metasternum together with the narrow side margins of the metasternum proper strongly alutaceous, abdominal sternites highly polished, without punctures except for a few along apical margin. Front femora alutaceous, middle and hind femora finely punctured and sparsely hairy.

Type and paratype.—U.S.N.M. no. 53945.

Type locality.—Luzon, Philippine Islands. The type and paratype were taken on Mount Makiling by C. F. Baker. A third specimen that appears to belong to this species was taken at Zamboanga, Mindanao, P. I., by Baker.

Serangium luzonicum, n. sp.

Length 2.2 mm; width 1.9 mm; altitude 0.6 mm. Dark castaneous, head and under parts somewhat paler. Head finely, irregularly, and rather sparsely punctured, punctures poorly defined, mostly setigerous. Pronotum with similar though slightly coarser punctures, which are largely wanting along a narrow median longitudinal line, setae sparse and not long, rather more densely set in anterior angles. Scutellum without visible punctures. Elytra distinctly and rather evenly punctured, the punctures very poorly defined, setigerous punctures present across base and in a row parallel to the lateral margin. Epipleura sparsely set with short setae. Prosternum shining, moderately densely punctured and hairy. Mesosternum very short, shining, without visible punctures. Metasternum proper shining, very sparsely set with very fine punctures, which bear short setae, side pieces strongly alutaceous, sparsely hary. Abdominal sternites shining, first four very sparsely set with setigerous punctures, fifth rather densely punctured and hairy. Front femora strongly alutaceous, other femora shining, the hind pair moderately densely hairy.

Type and four paratypes.—U.S.N.M. no. 53946.

Type locality.—Luzon, Philippine Islands. Type and one paratype collected at Manila by W. Schultze, two paratypes taken at the same place by George Compere, and one paratype from Bacoor (9 miles south of Manila) taken by P. L. Stangl.

Serangium metasternalis, n. sp.

Length 1.7 mm; width 1.4 mm; altitude 0.6 mm. Dark castaneous to piceous, head and legs paler. Head very finely punctured, the punctures more densely placed toward the clypeal region, where the vestiture of fine hair is rather dense. Pronotum with the punctures coarser than those on head and gathered into two moderately dense patches on each side of the narrow smooth median line. Vestiture sparse and fine. Scutellum not visibly punctured. Elytra sparsely punctured, the punctures visible only under high magnification, without setae except near humeral callus and along lateral margin. Epipleura not visibly punctured. Prosternum evenly and rather strongly alutaceous, very sparsely hairy. Mesosternum smooth at middle, with a small patch of setae at side. Metasternum proper smooth at middle and sparsely and finely punctured; laterally there is a triangular area adjacent to the side piece that, like the side piece itself, is strongly alutaceous. Abdominal sternites one to four finely and sparsely punctured, fifth sternite much more densely punctured and moderately densely hairy. Front femora strongly alutaceous, middle and hind femora smooth and sparsely hairy.

Type and paratype.—U.S.N.M. no. 53947.

Type locality.—Luzon, Philippine Islands. The type and paratype are from Manila, collected by George Compere. With these I have associated a third specimen from Biliran Island, collected by C. F. Baker.

Serangiella, n. gen.

Oeneis Motschulsky, 1866, *nec* Mulsant, 1850.
Cryptognatha Crotch, 1874, *nec* Mulsant, 1850.

Coccinellidae similar in form to *Serangium*. Head convex, eyes relatively coarsely faceted, slightly emarginate adjacent to antennal sockets, without canthus; distance between inner margins of antennal sockets equal to one-half distance between eyes; antennae sockets strongly transverse, with finely beaded margin, which is apparently not continuous across anterior margin of clypeus; clypeus very short and strongly transverse: antennae 9-segmented, first segment stout, second stout and but little more than half length of first, third strongly obtriangular, a little longer than second and not so long as fourth to eighth combined, these segments becoming successively wider until the eighth, which is almost as wide as the third, ninth segment almost as long as third to eighth combined, width equal to more than half its length; mandible very small, roughly quadrate, the inner or cutting margin feebly curved, the outer margin acutely angulate just before middle of length, prostheca apparently not present; terminal segment of maxillary palpus rather strongly inflated, subtruncate apically. Pronotum short, strongly transverse, anterior angles slightly prominent and strongly rounded, posterior angles acute, marginal line complete though very fine anteriorly. Prosternum strongly developed, truncate anteriorly, deeply notched laterally for reception of antennae, median portion strongly bicarinate, the carinae strongly divergent anteriorly. Mesosternum extremely short. Metasternum long and broad, all coxae widely separated, the hind coxae especially so. Femora broad, middle and hind tibia conspicuously angulate externally beyond middle, tarsi with four distinct segments, the third half as long as but of same diameter as fourth. Claws thickened at base but without distinct tooth. Scutellum small, triangular. Elytra with rather narrow somewhat concave epipleura, impressed for reception of apices of femora. Abdomen of five visible sternites, as in *Catana*.

Genotype.—*Oeneis flavescens* Motschulsky, 1866.

Although I have been able to examine only the one species, I feel reasonably certain that the other two Ceylonese species described by Motschulsky (1866, p. 423), *Oeneis laterale* and *O. nigritulum*, also should be referred to this genus. In fact, it is not evident from the original description that the three species are truly distinct. Figs. 21–24.

LITERATURE CITED

BLACKBURN, T. *Further notes on Australian Coleoptera, with descriptions of new species.* Trans. Royal Soc. South Australia **11**: 187, 209. 1889.

CASEY, T. L. *A revision of the American Coccinellidae.* Journ. New York Ent. Soc. **7**: 71–169. 1899.

———*Addition to the known Coleoptera of North America.* Memoirs Coleopt. **11**: 155–176. 1924.

CHAMPION, G. C. *Notes on various Central American Coleoptera, with description of new genera and species.* Trans. Ent. Soc. London, 1913, pp. 120–128. 1913.

CLAUSEN, C. P., and BERRY, P. A. *The citrus blackfly in Asia, and the importation of its natural enemies into tropical America.* U. S. Dept. Agr. Techn. Bull. **320**: 36–42. 1932.

CROTCH, G. R. *A revision of the coleopterous family Coccinellidae*, pp. 206–208. London, 1874.

GRANDI, G. *Descrizione di un nuovo Coccinellide africano.* Boll. Lab. Zool. Portici **8**: 165–178, figs. 1–8. 1914.

MOTSCHULSKY, V. DE. *Essai d'un catalogue des insectes de l'ile Ceylan.* Bull. Soc. Hist. Nat. Moscow **39**: 422–426. 1866.

MULSANT, E. *Species des coléoptères trimères sécuripalpes*, pp. 496–501. Paris and Lyons, 1850.

SICARD, A. *Revision des coccinellides de la faune malgache.* Ann. Soc. Ent. France **78**: 150–155. 1909.

———*Descriptions de quelques espèces nouvelles de coccinellides de la faune Indo-Malaise.* Ann. Mag. Nat. Hist. (10) **3**: 179–184. 1929.

WEISE, J. *Kleine Beiträge zur Coccinelliden. Fauna Ost-Afrika's.* Deutsche ent. Zeitsch., 1892, pp. 15–16. 1892.

———*Über Chrysomeliden und Coccinelliden der Philippinen. II Teil (Coleoptera.)* Philippine Journ. Sci. **8D**: 241–242. 1913.

ENTOMOLOGY—*Siphonaptera from Western United States.*[1] IRVING FOX, Iowa State College, Ames, Iowa. (Communicated by C. F. W. MUESEBECK.)

The following descriptions, involving three new species and a new subgenus, are based upon material in the United States National Museum and in the author's private collection. Type material is in the United States National Museum, to whose authorities the author expresses his appreciation for the privilege of studying the collections in their charge. Particular thanks are due to Dr. H. E. Ewing, of the Bureau of Entomology and Plant Quarantine, for his kindness and assistance.

Family HYSTRICHOPSYLLIDAE

Corypsylloides Hubbard

Corypsylloides Hubbard, Pacific Univ. Bull. **37**: 7. 1940.

Front reduced; frontal tubercle and notch absent. Gena much enlarged; genal ctenidium obliquely vertical consisting of six spines, the lowermost reduced in width. Eyes absent. Labial palpus 5-segmented, the last segment

[1] Received February 2, 1940.

tapering distally. Pronotum rounded cephalad, well separated from the head, bearing on the posterior margin a ctenidium consisting of spines of various sizes. Mesopleuron not divided by a vertical rodlike sclerotization into a mesoepisternum and a mesepimeron. Line of division between metepisterna and metepimeron not distinct. Abdominal tergites armed with apical spines but no heavy transverse incrassations. Each abdominal tergite with one row of four bristles, two situated laterally and two dorsally. In male the posterior arm of sternite IX absent; sternite VIII not modified; manubrium laterad to rest of the clasper rather than ventrad to it. Coxa III with a patch of spinelets on the inside. Last segment of each tarsus with four pairs of lateral plantar bristles.

This genus is most closely allied to *Corypsylla* C. Fox from which it may be readily separated by the absence of heavy transverse incrassations on the abdominal tergites and by the character of the genal ctenidium. It is easily distinguished from *Nearctopsylla* Rothchild, which it superficially resembles, by the structure of the thorax.

Corypsylloides spinata, n. sp. Figs. 1, 2, 4

Male.—Preantennal region of head armed with a frontal row of four bristles and a small bristle at the base of first, third, fourth, and fifth genal spines; several other small bristles located along dorsal margin of head. Spines of genal ctenidium arranged as in Fig. 1. Postantennal region armed with three bristles in addition to a marginal row of about five. Labial palpus barely reaching to apex of fore coxa. Pronotum with a medial row of but three long bristles and a ctenidium of about 15 spines on a side. Mesopleuron with four bristles, two in center and two at posterior margin; metepisternum with two or three bristles, of which one is long and one or two are minute; metepimeron with four bristles. One antepygidial bristle present on a side.

Modified segments.—Process of clasper and movable finger as in Fig. 2. Spring short, not completing a single turn. Total length, 1.8 mm. Greatest depth of abdomen, 0.5 mm.

Female.—A large bristle located on gena near third antennal segment; otherwise, chaetotaxy of head as in male. Pronotal ctenidium consisting of about 13 spines on a side. Two antepygidial bristles present on a side. Receptaculum seminis and sternite VII as in Fig. 4. Total length, 1.9 mm. Greatest depth of abdomen, 0.6 mm.

Type host and type locality.—Meadow mouse, *Microtus townsendii*, at Portland, Oreg.

Type slide.—U.S.N.M. no. 54011.

Type material.—Male holotype and female allotype collected by S. G. Jewett from *Microtus townsendii*, December 24, 1931, at Portland, Oreg.; in the United States National Museum. Four male and two female paratypes bearing the same data in the author's private collection.

Family DOLICHOPSYLLIDAE

Amphipsylla neotomae, n. sp. Fig. 3

Male.—Frontal tubercle indistinct. Preantennal region of head armed with an ocular row of three bristles, which lies below two bristles located near antennal groove. Postantennal region with a single bristle in addition to a marginal row of about seven. Eye vestigial, the vestiges not pigmented. Labial palpus extending to about three-fourths the length of fore coxa.

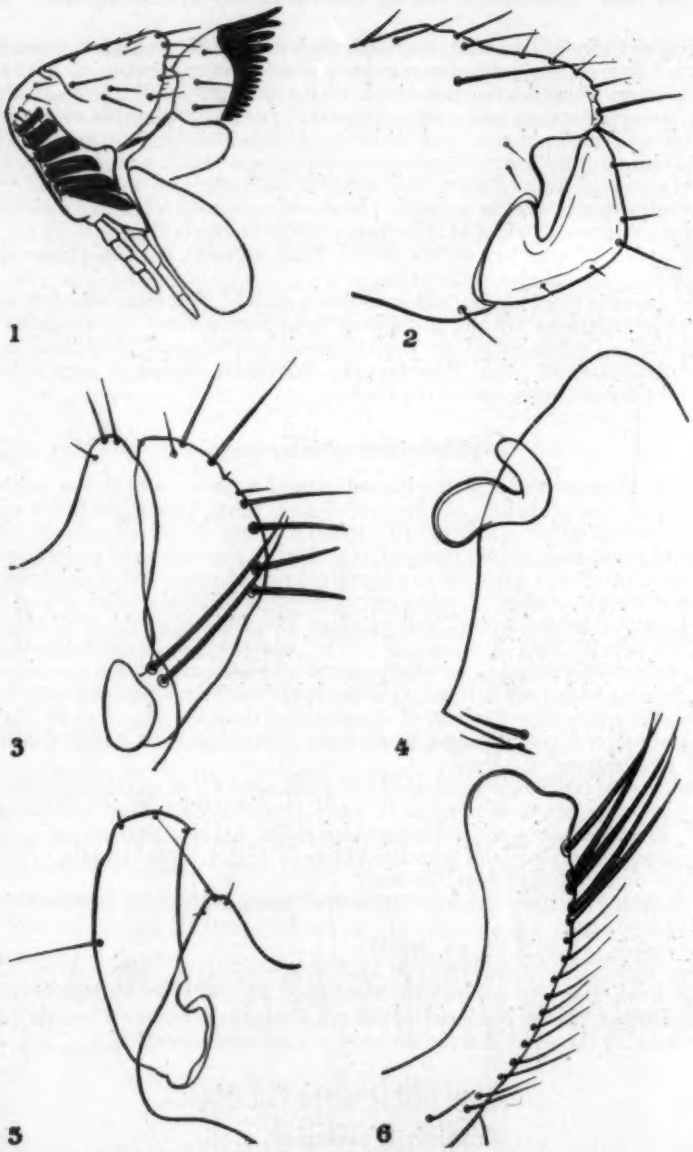


Fig. 1.—*Corypsylloides spinata*, n. sp., head of male. Fig. 2.—*idem*, process of clasper and movable finger. Fig. 3.—*Amphipsylla neotomae*, n. sp., process of clasper and movable finger. Fig. 4.—*Corypsylloides spinata*, n. sp., receptaculum seminis and sternite VII. Fig. 5.—*Dactylopsylla* (*Spicata*) *rara*, n. sp., process of clasper and movable finger. Fig. 6.—*idem*, sternite VIII of male.

Pronotal ctenidium with about 13 spines on a side. One long antepygidial bristle between two minute ones present on a side.

Modified segments.—Process of clasper and movable finger as in Fig. 3; the latter armed on posterior margin with three prominent spiniform bristles in addition to several others. Spring short, not completing a single turn. Total length, 3.4 mm. Greatest depth of abdomen, 1.1 mm.

Type host and type locality.—Wood rat, *Neotoma desertorum*, at Dos Palos, Calif.

Type slide.—U.S.N.M. no. 54012.

Type material.—Male holotype collected by H. S. Gentry from *Neotoma desertorum*, March 1934, at Dos Palos, Calif.; in U. S. National Museum.

But two members of this genus have heretofore been reported from North America, *A. sibirica pollionis* Rothschild from Alberta and *A. ewingi* I. Fox from Alaska. The above described new species may be separated from both of these by the structure of the male genitalia. It represents the first record of the occurrence of the genus *Amphipsylla* within the United States.

Genus DACTYLOPSYLLA Jordan

Spicata, n. subgen.

Frontal tubercle prominent, not acuminate. Eye vestigial, the vestiges indistinct. Pronotum armed with a ctenidium of long slender spines. In male sternite VIII broad and prominent, armed on the posterior margin with a number of bristles of which some are robust and heavily pigmented (Fig. 6). Anterior arm of sternite IX much narrower than in *Dactylopsylla* (*Dactylopsylla*). Manubrium not short and triangular, tapering and curved distally.

Type species.—*Dactylopsylla* (*Spicata*) *rara*, n. sp.

This new subgenus may be readily distinguished from *Dactylopsylla* (*Dactylopsylla*) and from *Foxella* Wagner by the structure of the male genitalia. In the type subgenus sternite VIII is large but not armed with heavy pigmented bristles. In *Foxella* this sternite is small and bears but a single long bristle near the apex. The manubrium of the new subgenus, being narrow and tapering distally, is markedly different from both *Foxella* and *Dactylopsylla* (*Dactylopsylla*) where this structure is short, broad, and triangular.

Dactylopsylla (Spicata) rara, n. sp. Figs. 5, 6

Male.—Preantennal region of head armed with two rows of bristles; the upper row consisting of about five, the lower row of four. Eye vestigial, the vestiges exceedingly small and inconspicuous. Postantennal region of head armed with a marginal row of six or seven bristles. Labial palpus extending beyond basal half of fore coxa. Pronotal ctenidium consisting of about 14 spines on a side.

Modified segments.—Movable finger and process as in Fig. 5; the former differing in structure on the two sides. In one case the movable finger is armed with one bristle on the posterior margin (Fig. 5), while in the other it is armed with three bristles and there are slight differences in the shape of the structure. Posterior arm of sternite IX with a number of small bristles distally. Sternite VIII broad, wider distally and armed on posterior margin with five or six heavily pigmented bristles and about a dozen much more slender ones. Total length, 4.5 mm. Greatest depth of abdomen, 1.5 mm.

Type host and type locality.—Pocket gopher, *Thomomys fossor*, Jackson County, Colo.

Type slide.—U.S.N.M. no. 54013.

Type material.—Male holotype collected by S. C. McCampbell from *Thomomys fossor* in Jackson County, Colo., July 13, 1926; in the United States National Museum.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ACADEMY

359TH MEETING OF THE BOARD OF MANAGERS

The 359th meeting of the Board of Managers was held in the Board Room of the Cosmos Club on Friday, February 9, 1940. President CRITTENDEN called the meeting to order at 8:00 P.M.

The attendance was as follows:

E. C. CRITTENDEN	G. STEINER	A. WETMORE	E. W. PRICE
F. D. ROSSINI	J. E. GRAF	F. O. COE	C. L. GARNER
F. C. KRACEK	W. B. BELL	C. THOM	H. G. DORSEY
H. S. RAPPLEYE	A. T. MCPHERSON	P. C. WHITNEY	C. L. GAZIN
J. H. HIBBEN	A. H. CLARK	H. L. CURTIS	W. W. DIEHL

and by invitation: H. B. COLLINS, JR., and J. H. KEMPTON.

The following budget was adopted for 1940:

Secretary's Office	$ 450.00	
Treasurer's Office	225.00	
Meeting's Committee	350.00	
Membership Committee	10.00	
Executive Committee	10.00	
Custodian of Publications	120.00	
Journal	2,500.00	plus receipts
Total	$3,665.00	plus Journal receipts

In addition to the reports of standing committees the Board received a petition signed by L. B. TUCKERMAN, O. E. MEINZER, W. J. HUMPHREYS, W. RAMBERG, C. THOM, and P. A. SMITH requesting a change in the bylaws restoring the offices of the two nonresident Vice-presidents eliminated by ballot January 9, 1940. The President appointed a special committee to consider this petition and make recommendations to the Board. This Committee has as its chairman H. L. CURTIS, with CHARLES THOM and P. C. WHITNEY as members.

The Board considered the nature of the ceremonies to be held in connection with the presentations of the Awards for Scientific Achievement and instructed the Committee on Meetings to make the necessary arrangements.

On recommendation of the Editors of the Journal, the Board authorized the President to appoint a committee to investigate the present status of the contract for printing the Journal and, if in their judgment advisable, to solicit bids for printing the Journal in 1941. The President appointed F. G. BRICKWEDDE chairman of this committee, with H. G. AVERS, R. W. BROWN, C. L. GAZIN, J. H. KEMPTON, R. J. SEEGER, and J. A. STEVENSON members.

The meeting adjourned at 10:52 P.M.